

Industrial Applications of Electricity



"THE MOST PERFECT MACHINE SHOP"--BUILDING NO. 16 OF THE SCHENECTADY WORKS OF THE GENERAL ELECTRIC COMPANY--THE IRON AGE, JAN. 4, 1900

General Electric Company

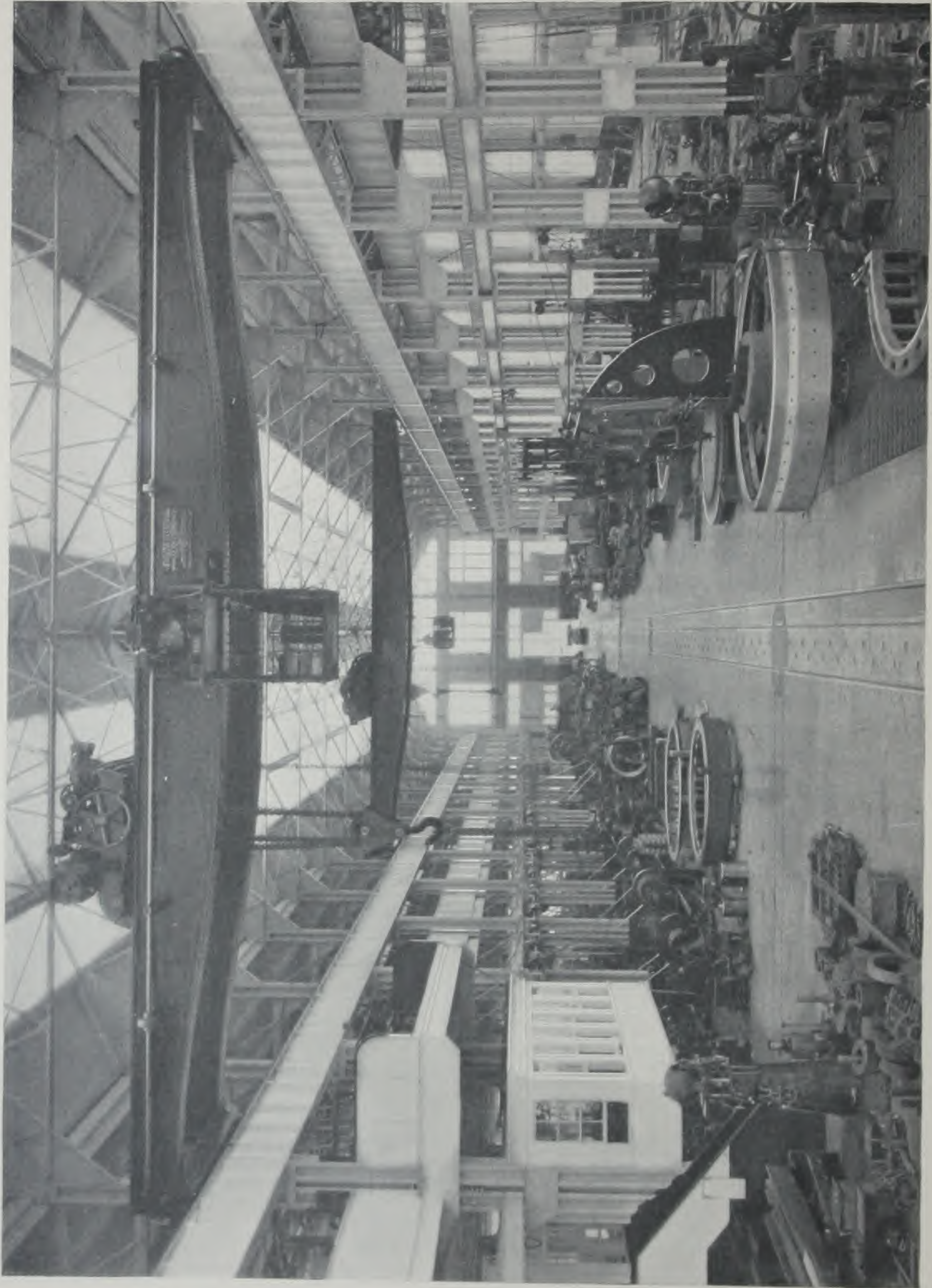
Power and Mining Department

Schenectady, N. Y.

Feb. 10, 1900

No. 1026

GENERAL ELECTRIC COMPANY



A MODERN MACHINE SHOP SHOWING TWO FORTY-TON CRANES AND TOOLS DRIVEN BY GENERAL ELECTRIC COMPANY'S MOTORS

INTRODUCTION

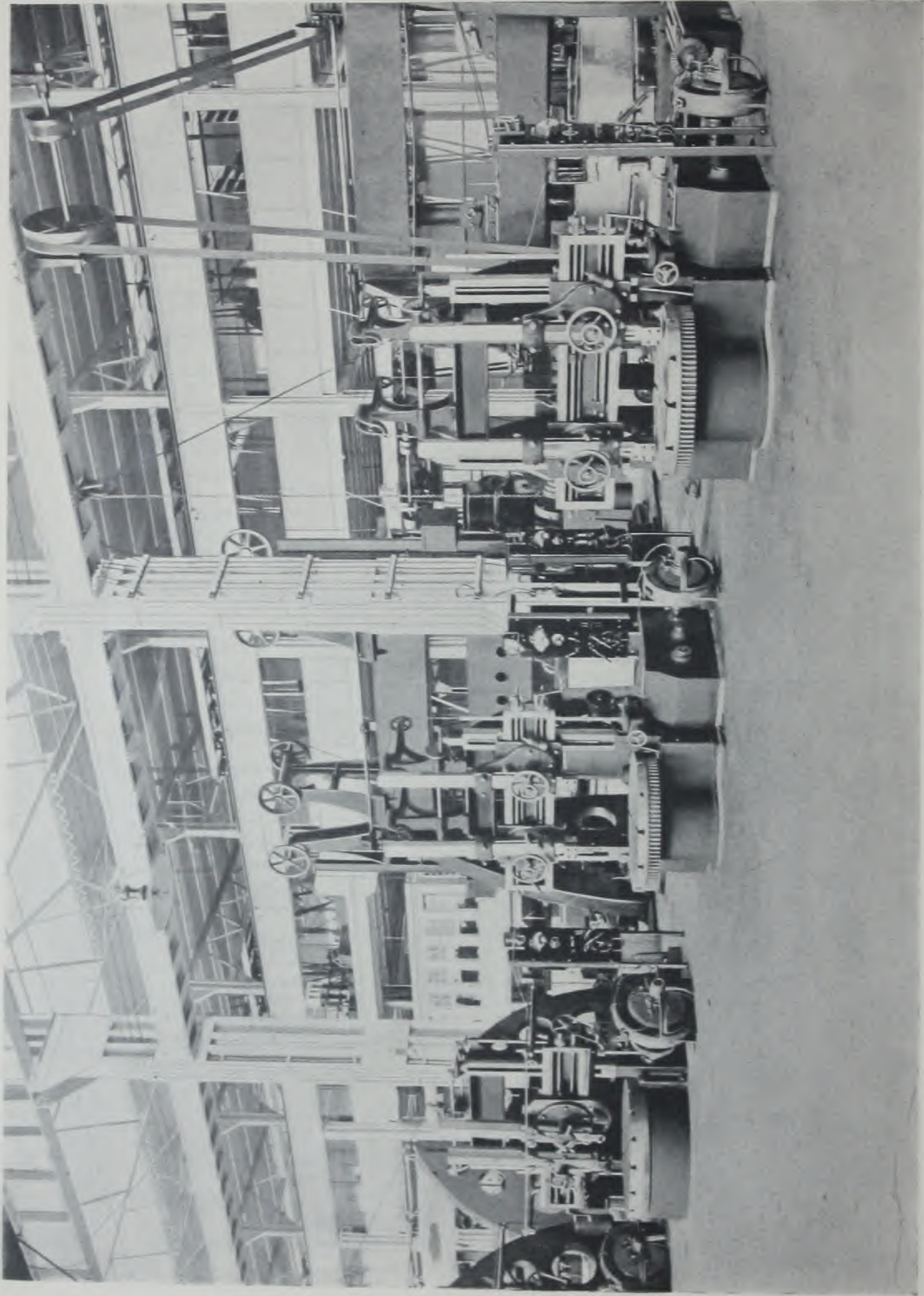
THE production of the best article at the lowest cost is the aim of every successful manufacturer. In considering any change from established methods of production, the natural question is: Will the proposed change in methods or appliances reduce the cost of manufacture or improve the quality of the product? The object of this pamphlet is to answer this question by showing wherein the use of electricity has largely contributed to these ends and to illustrate its application to various industries.

Ample and well distributed light is essential to good work, but still more important is the equipment of factories with the best system of power distribution. Although the electric light is universally acknowledged to be the best illuminant, it is less generally understood that electric power is the most economical, efficient, reliable, flexible, and convenient method of operating manufacturing establishments.

The long experience of the General Electric Company in the application of electricity to mechanical uses, justifies it in recommending the adoption of the electrical apparatus and devices described and illustrated in the following pages as a substitute for every other form of motive power.

With the aim of increasing the value of this pamphlet, descriptions of a few of the many plants erected by this Company, accompanied by suggestions intended to aid in the solution of the various problems arising in the installation of electric power, have been included.

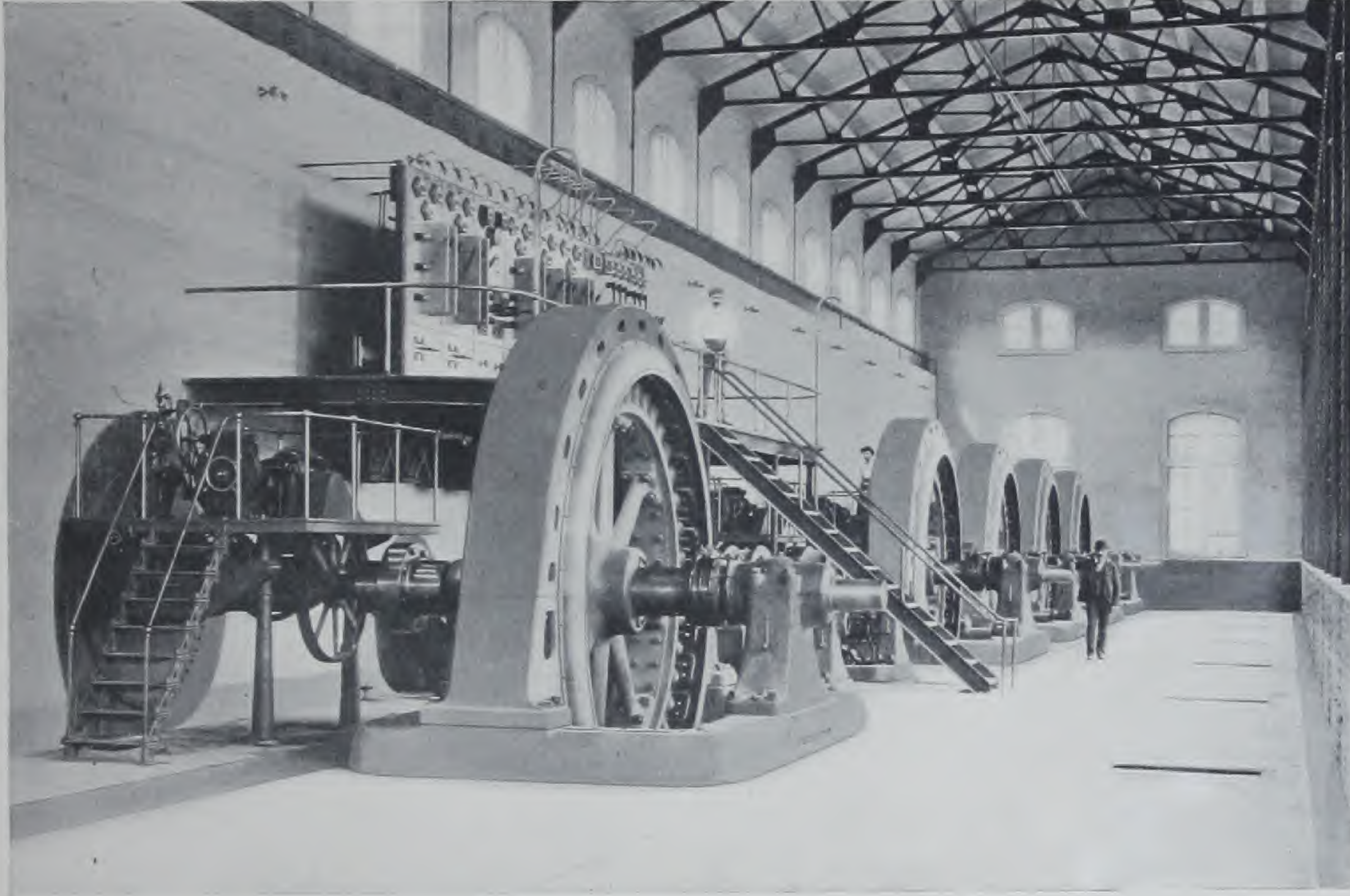
GENERAL ELECTRIC COMPANY



BORING MILLS OPERATED BY GENERAL ELECTRIC COMPANY'S VARIABLE SPEED MOTORS

SECURING CHEAP POWER

THE cost of power is a large item of expense in many kinds of manufacturing, and cheap power is often the factor which determines the location of new industries. If a water power is available its development will naturally be electrical.



Generator Room of the Hudson River Power Transmission Company, Mechanicville, N. Y.

By transforming the energy of the fall of water into electrical power, it may be transmitted to any reasonable distance and the most favorable factory site may be selected from considerations other than power.

In most large cities, central stations on account of their control of water power, or the larger size and more favorable location of their steam plants, primarily built to furnish power for electric lights or street railways, frequently sell power for motors more cheaply than it can be made by small establishments. When cheap electric power can be purchased, factories should take advantage of such an opportunity, as the use of electricity permits also many other savings.



FACTORY POWER PLANTS

THE managers of large establishments should consider the most economical methods not only for the immediate present, but also for their probable future needs.

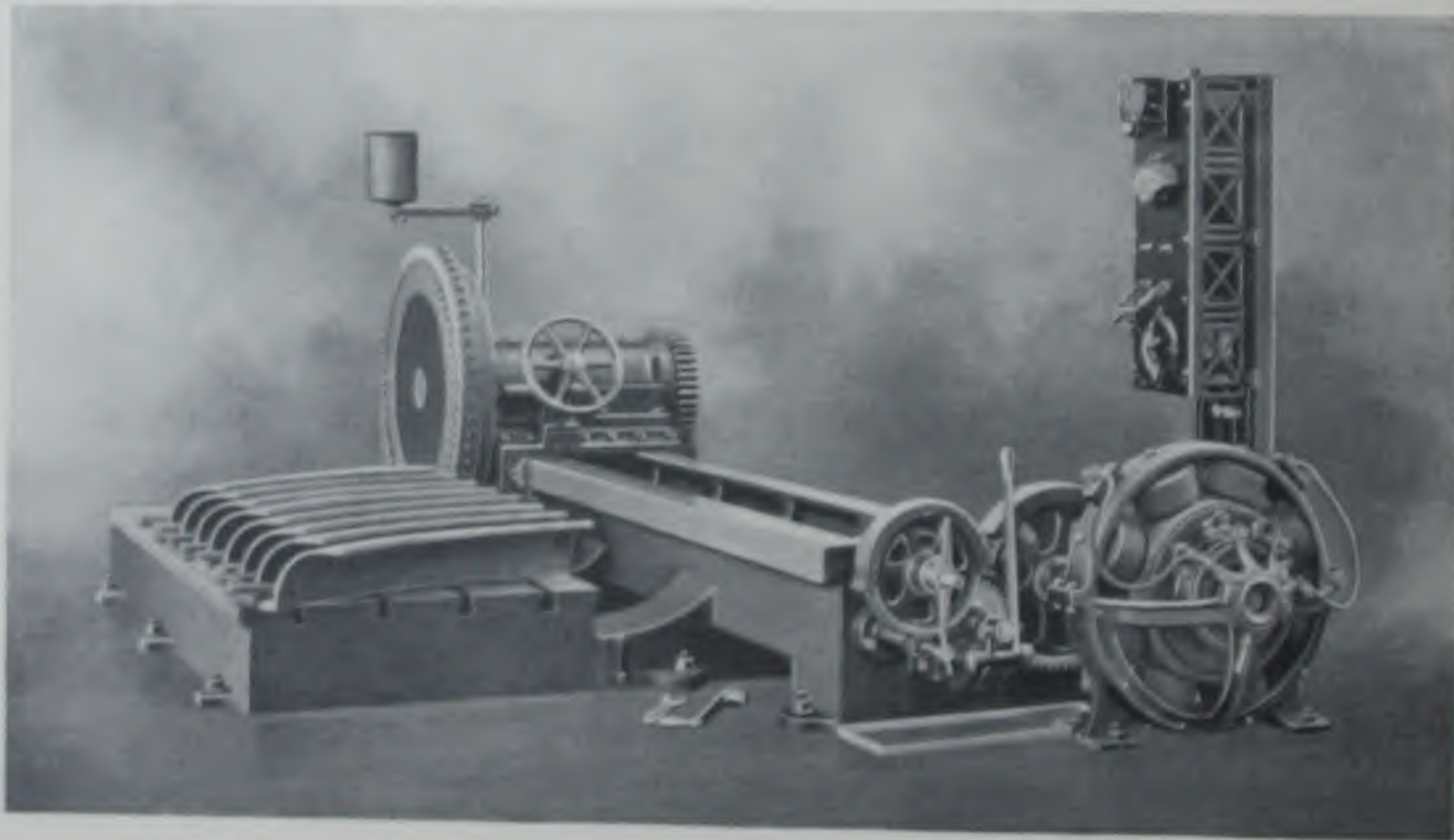
Few mills or factories now stand as originally built—practically all have undergone modification and enlargement. On this account small engines and boilers are found throughout the various buildings of many factories not using electric power, or steam is carried long distances to the engines with heavy loss due to condensation. The modern plan discards all the small and inefficient engines and substitutes a central electric plant for generating power at maximum efficiency.

The higher economy of large units of power is generally recognized, but the saving in labor which a central power station may effect is an important, though frequently disregarded commercial consideration. Separate power units scattered over a large manufacturing plant require many times the labor necessary to operate a single plant of equal capacity. If many engines are used to develop the power more engineers are required; and if the boilers are not under one roof, they require additional firemen and incur greater expense in handling coal and ashes.

The electric power house may be located at the point where fuel, feed and condensing water may be obtained cheapest and at any desired distance from the main plant.

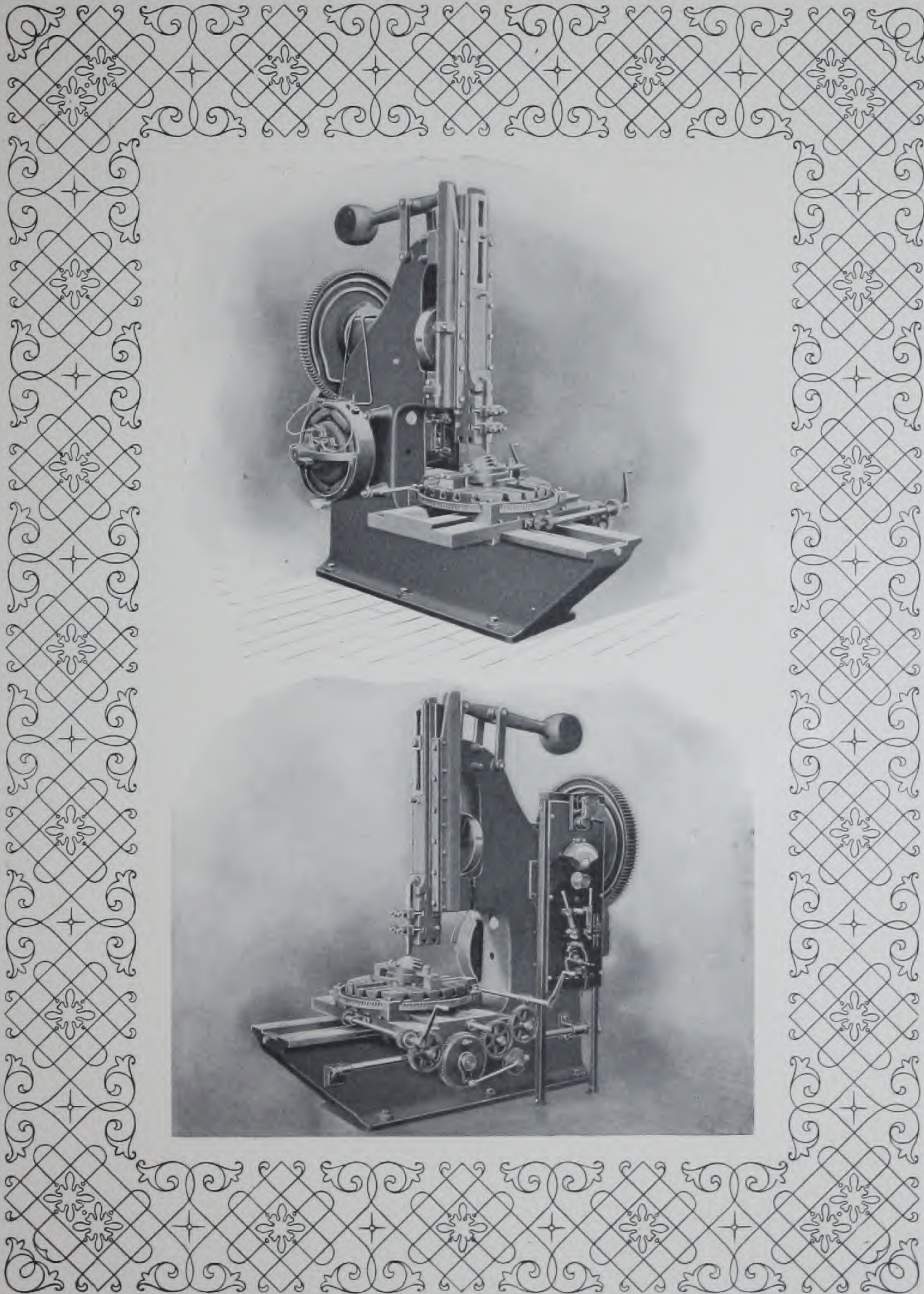
The inefficiency of underloaded steam engines is well known, yet it is common practice to install an engine for the maximum capacity ever required for a given shop and run it most of the time at partial loads.

In the electric central station, the sizes of the steam units may be so chosen that operation at the most efficient loads is always secured, the several engines being shut down or started up as they are needed. The equalization of the fluctuating loads of different departments is also accomplished by throwing them together in one station.



Forty-two inch Rotary Planer with Direct Connected General Electric Company's Motor

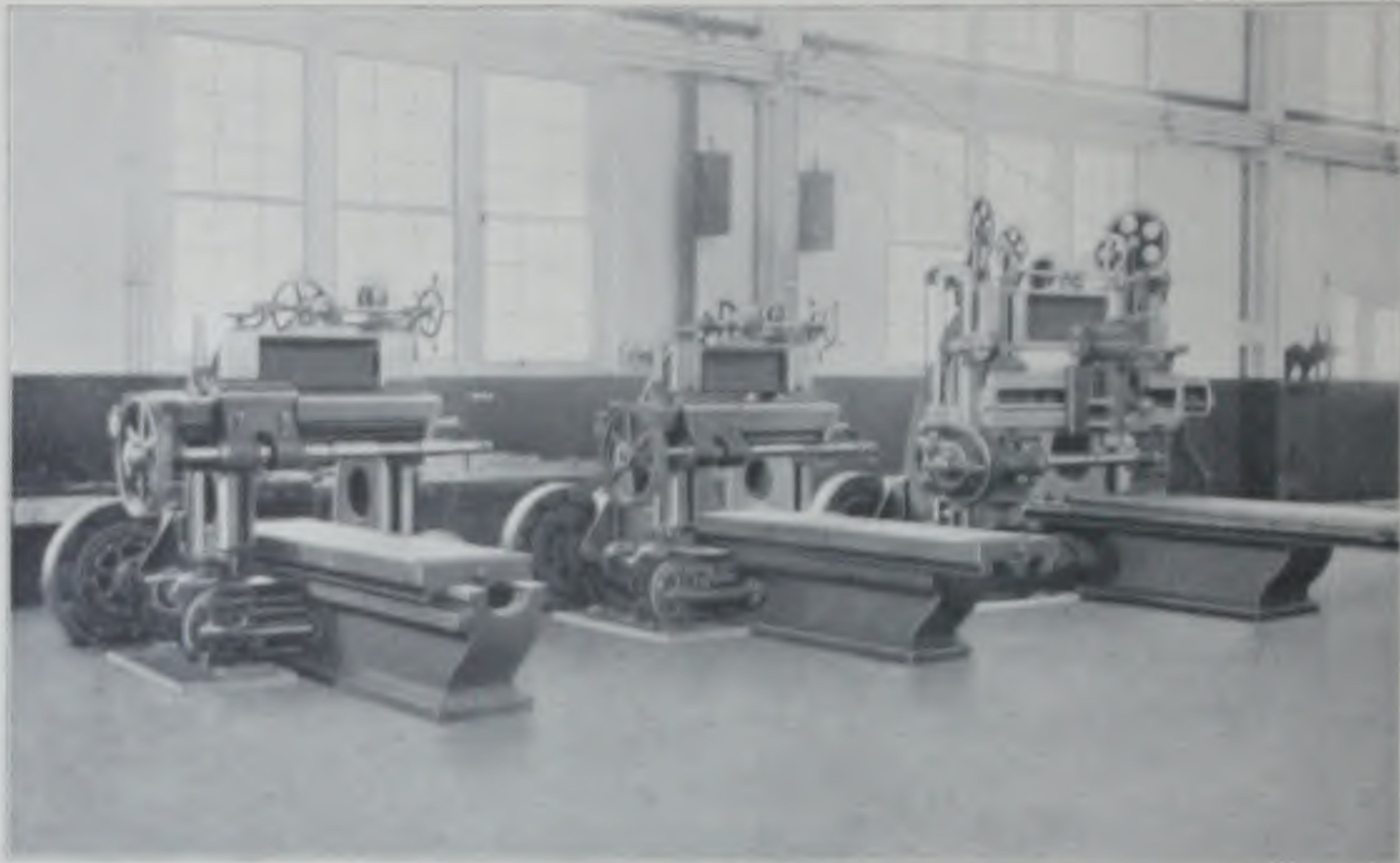
GENERAL ELECTRIC COMPANY



Two Views of Twelve-inch Slotting Machine Driven by Independent General Electric Company's Motor

ECONOMY IN DISTRIBUTION OF POWER

LOSSES attending transmission of power by shafting vary widely, depending upon the class of work, arrangement of machines, relative direction of shafts, and their adjustment, lubrication, and alignment. Instability of supports, which are usually placed under floors subjected to variable weights, is a frequent source of increased friction and loss.



Milling Machines with Direct Connected General Electric Company's Motors

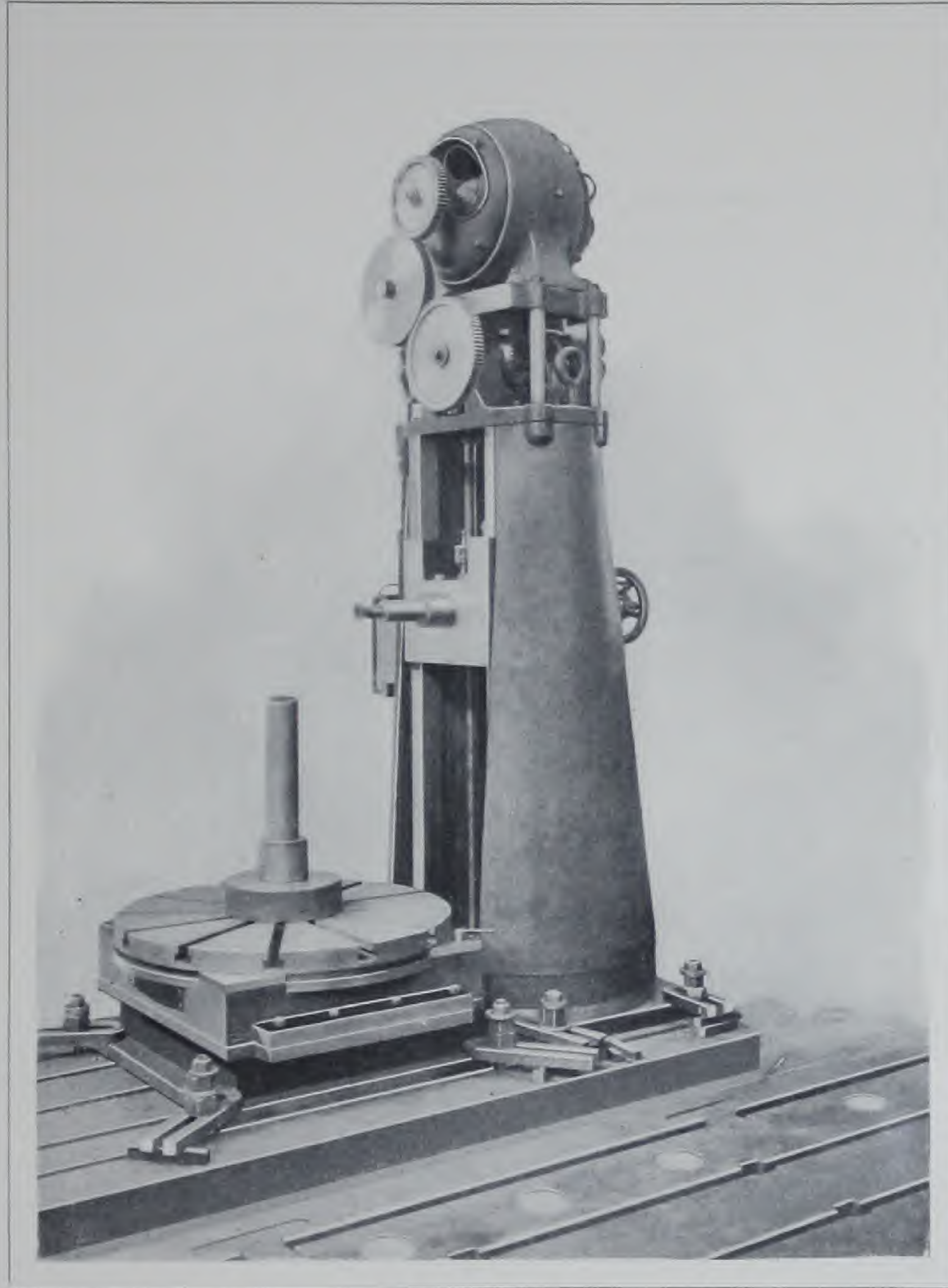
Experiments have been made by many competent engineers and carefully tabulated, showing the losses due to line shafts and belts in representative plants.

These tests have always been made by taking comparative engine indicator diagrams with the shafting alone and with the machinery in operation. They do not include all the transmission losses, as they neglect the power lost in slipping belts, etc., under load.

The results, however, show that the average efficiency by the ordinary methods of transmission is from 30% to 60%; or, in other words, the losses are from 65% to 230% of the effective power delivered to the tools. Some tests show as low an efficiency as 25%, and only in rare cases is the efficiency above 75% at full load.

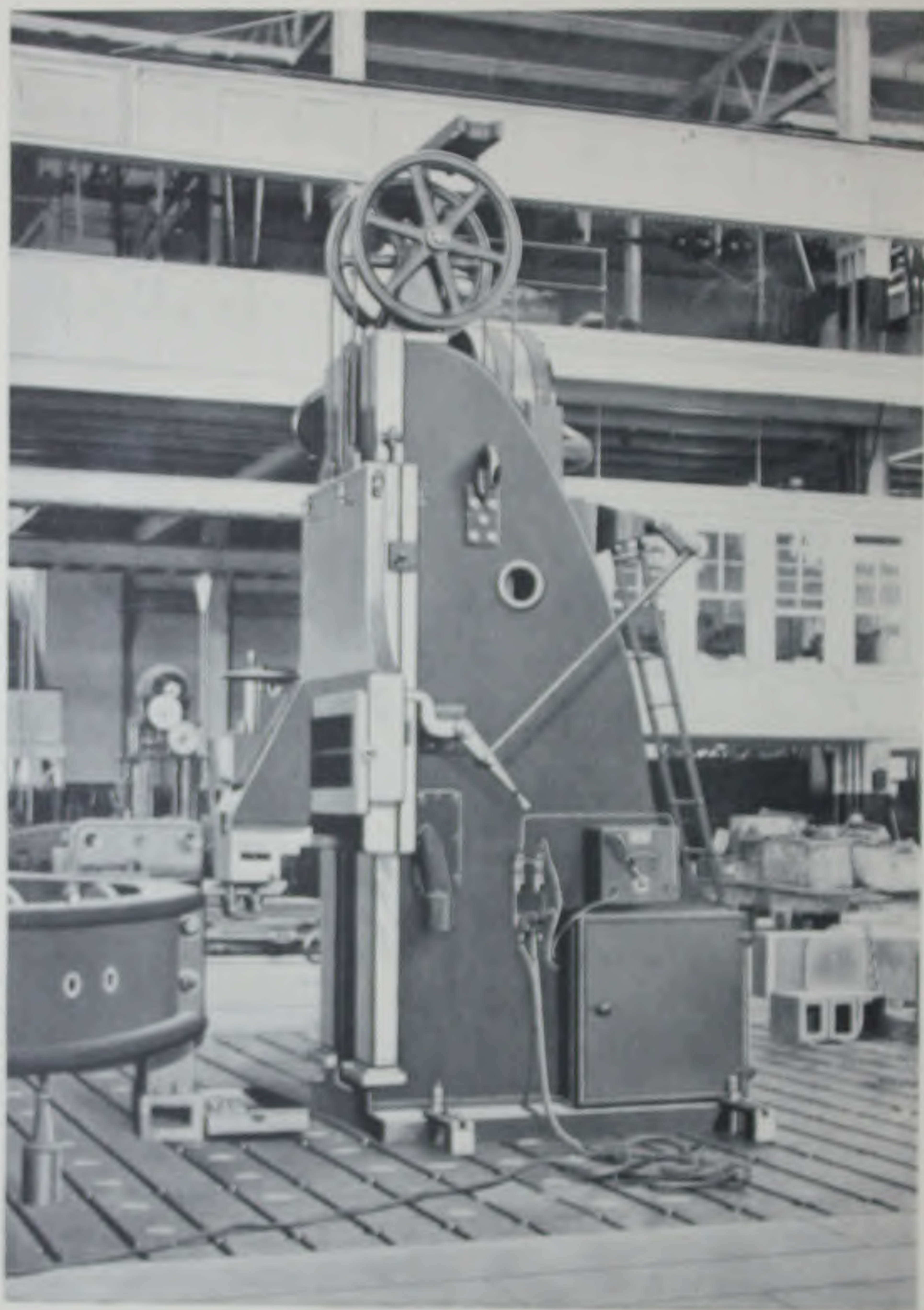
In the electric system, on the other hand, the efficiency of transmission can be exactly predetermined and usually varies, depending on the investment in copper, from 2% to 10%. The losses in the motor and generator, which together will amount to from 15% to 25%, depending on the sizes of generators and motors employed, must be added to the loss in transmission giving a total efficiency from 65% to 83% from the engine to the machines.

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Portable Milling and Drilling Machine with General Electric Company's Motor

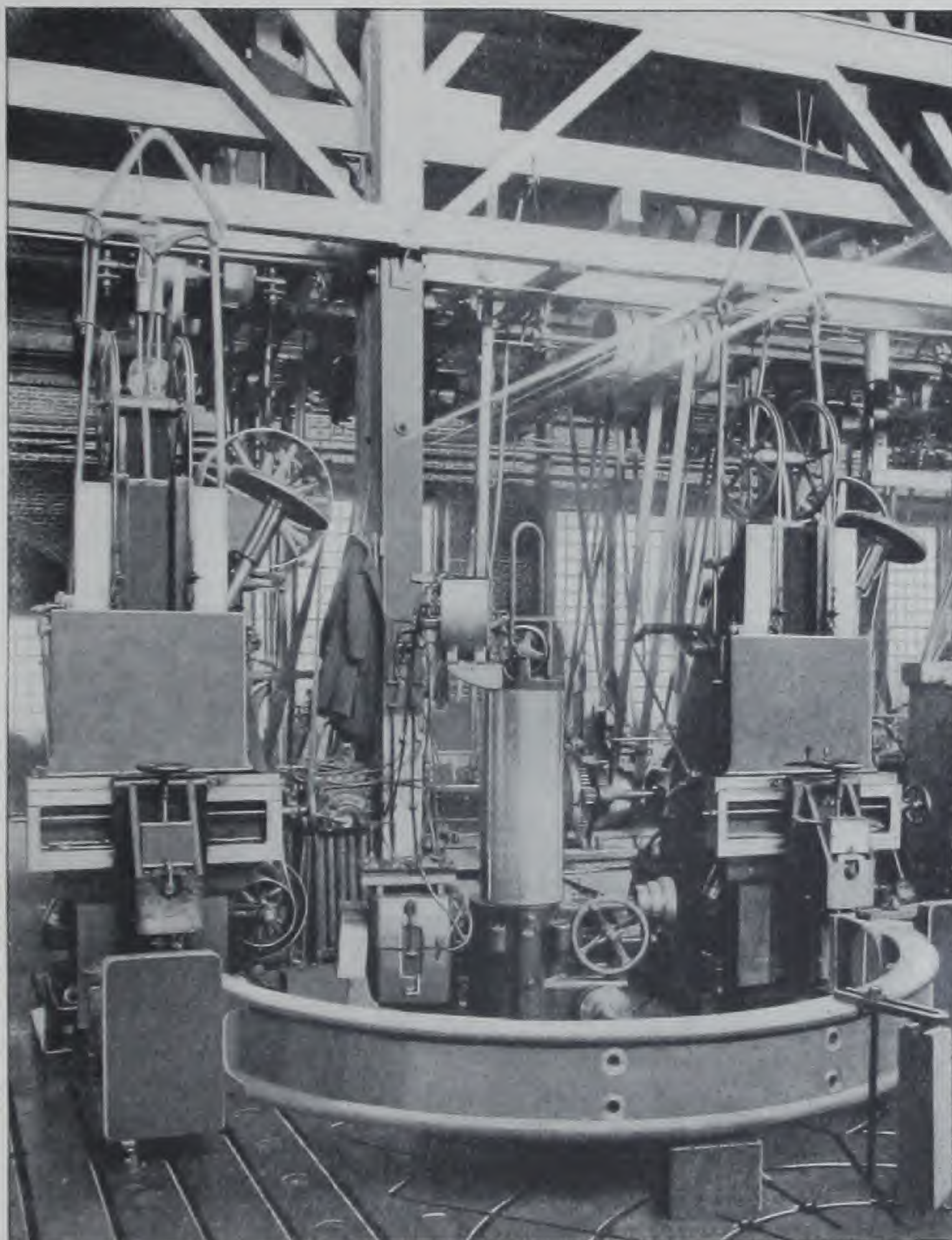
GENERAL ELECTRIC COMPANY



Portable Dynamo Starting Machine with General Electric Company's Motor Inside

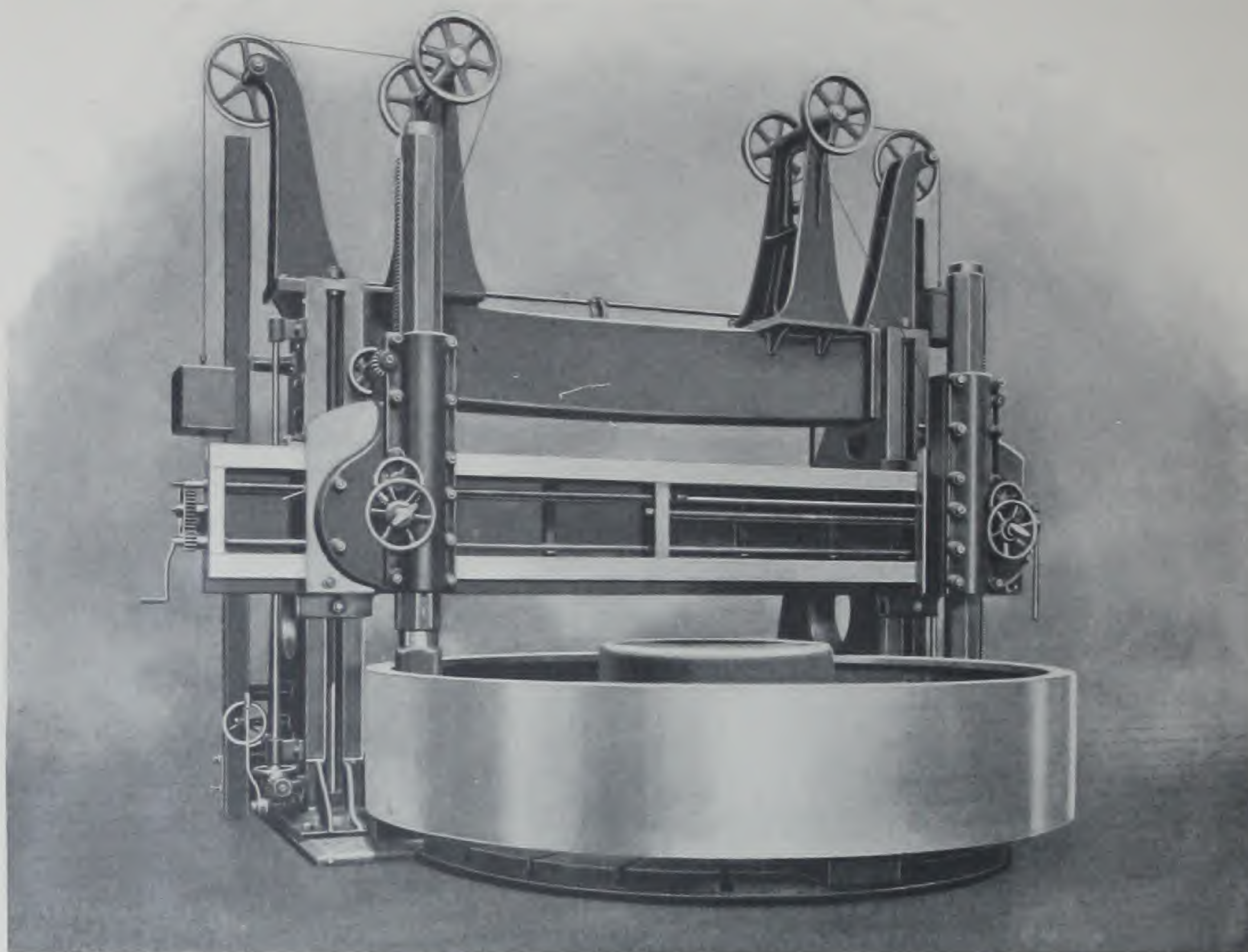
AN EXAMPLE OF SHOP TRANSMISSION

AS a comparison between mechanical and electrical transmission, assume that we have to deliver power to machinery requiring 150 H.P. With a shafting transmission of average efficiency (50%), we will require 300 H.P. in engine capacity. With an electric transmission, each machine requiring 5 H.P. or more may be



Two Portable Slotters and Portable Drill at Work on One Casting

driven by its own motor, and motors may be used whose efficiency under average load is at least 85%. Then, to deliver 150 H.P., we require an input at the motor terminals of $176\frac{1}{2}$ H.P. The loss in the line can advantageously be made less than 5%, the only limit being the cost of the copper. Thus the generator must deliver 186 H.P. to the line; and as a generator of this capacity should have an efficiency at full load of about 92%, the total loss from the pulley of the engine to the machine tool is but 25%, or the efficiency of the transmission is 75%. The required engine capacity would therefore be 202 H.P., whereas with shafting transmission of average efficiency, a 300 H.P. engine would be needed.

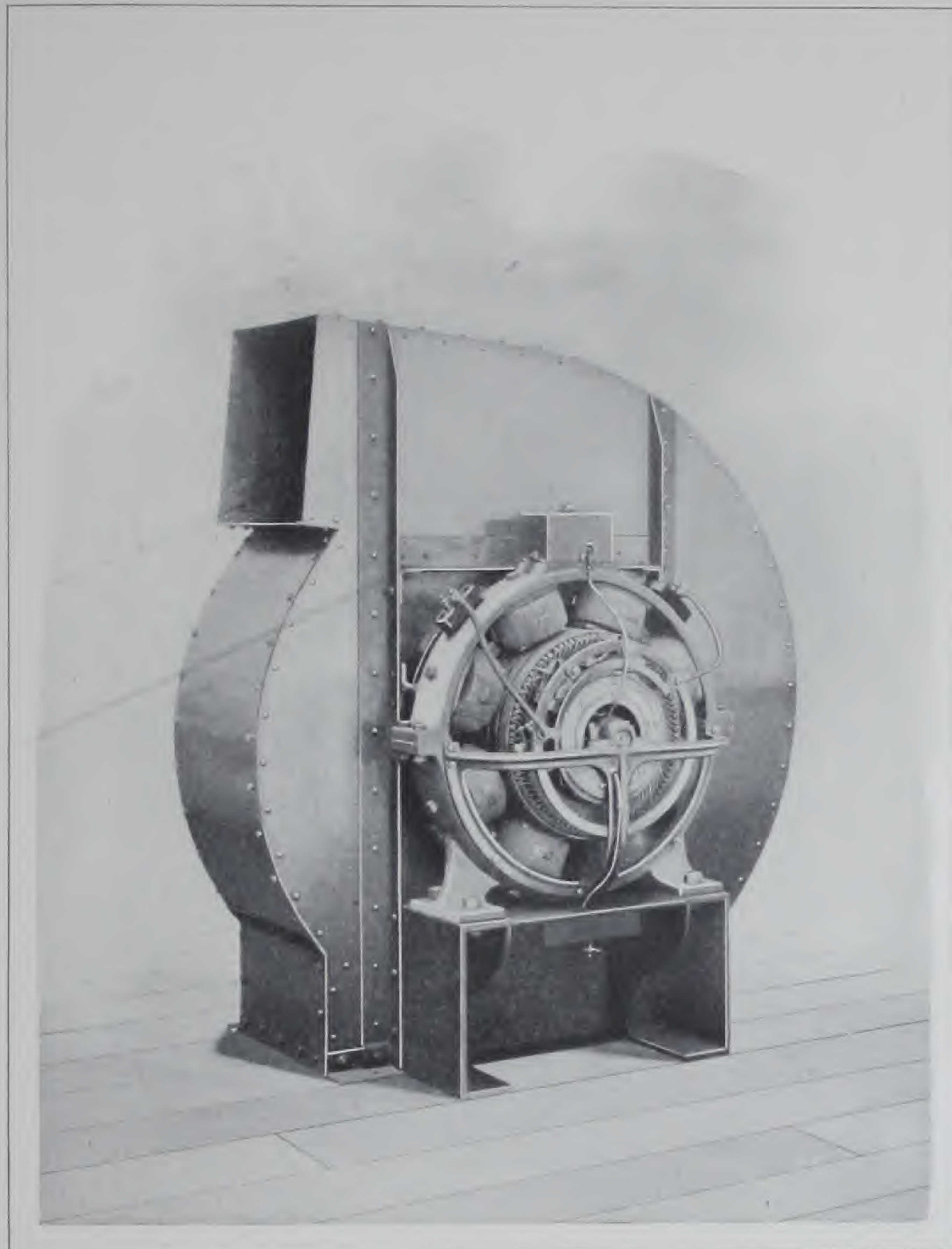


Twenty-foot Boring Mill Geared to General Electric Company's Motor (Under Floor)

EFFICIENCY AT PARTIAL LOADS

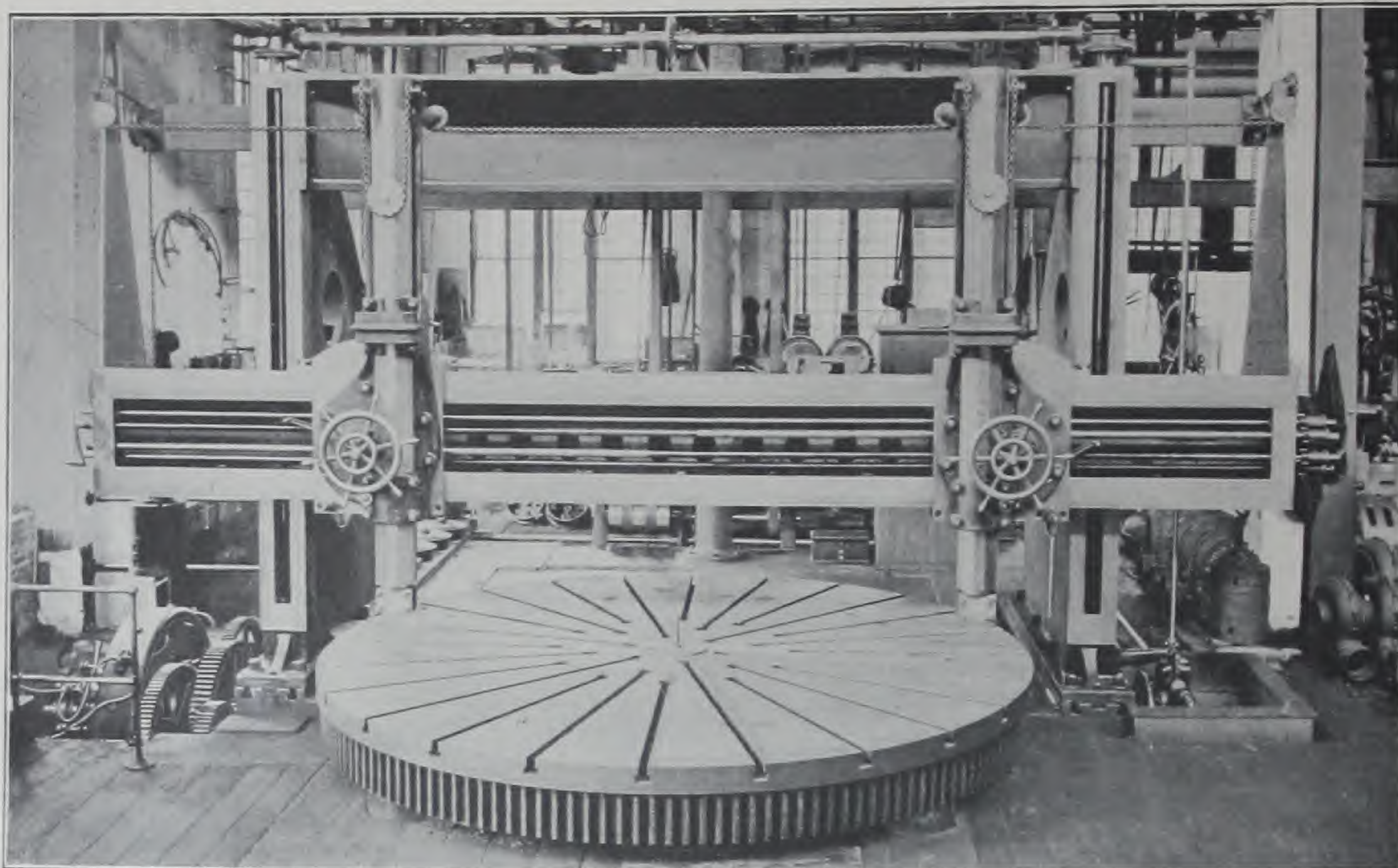
A plant is not always running at its full capacity, and for fairness, we must also make a comparison under partial load conditions. In a mechanical drive, the losses are practically constant, since provision for cutting out sections of line shafting is usually impracticable, and not often made. Therefore, as the effective work is reduced, the efficiency of transmission decreases. Thus, in the case previously assumed, the efficiency of the shafting transmission at full load is 50%, but there is a constant loss of 150 H.P. even at lower load. If only 75 H.P. be required, or if one-half of the machinery be in operation, the engine must give an output of 225 H.P., and the efficiency of transmission drops from 50% to 33%. Using electricity, however, the results are very different, as the losses are not constant but vary with the load. The line loss decreases directly with the load, and well designed generators and motors have but slightly less efficiency at partial than at full load. When an electrically driven plant operates at half load, half of the motors may generally be shut down, so that the total efficiency of the electric system may be as high or higher than at full load. In our assumed case, an engine output of only 100 H.P., or less than half the power necessary for a mechanical drive, would be required for the electric system.

GENERAL ELECTRIC COMPANY

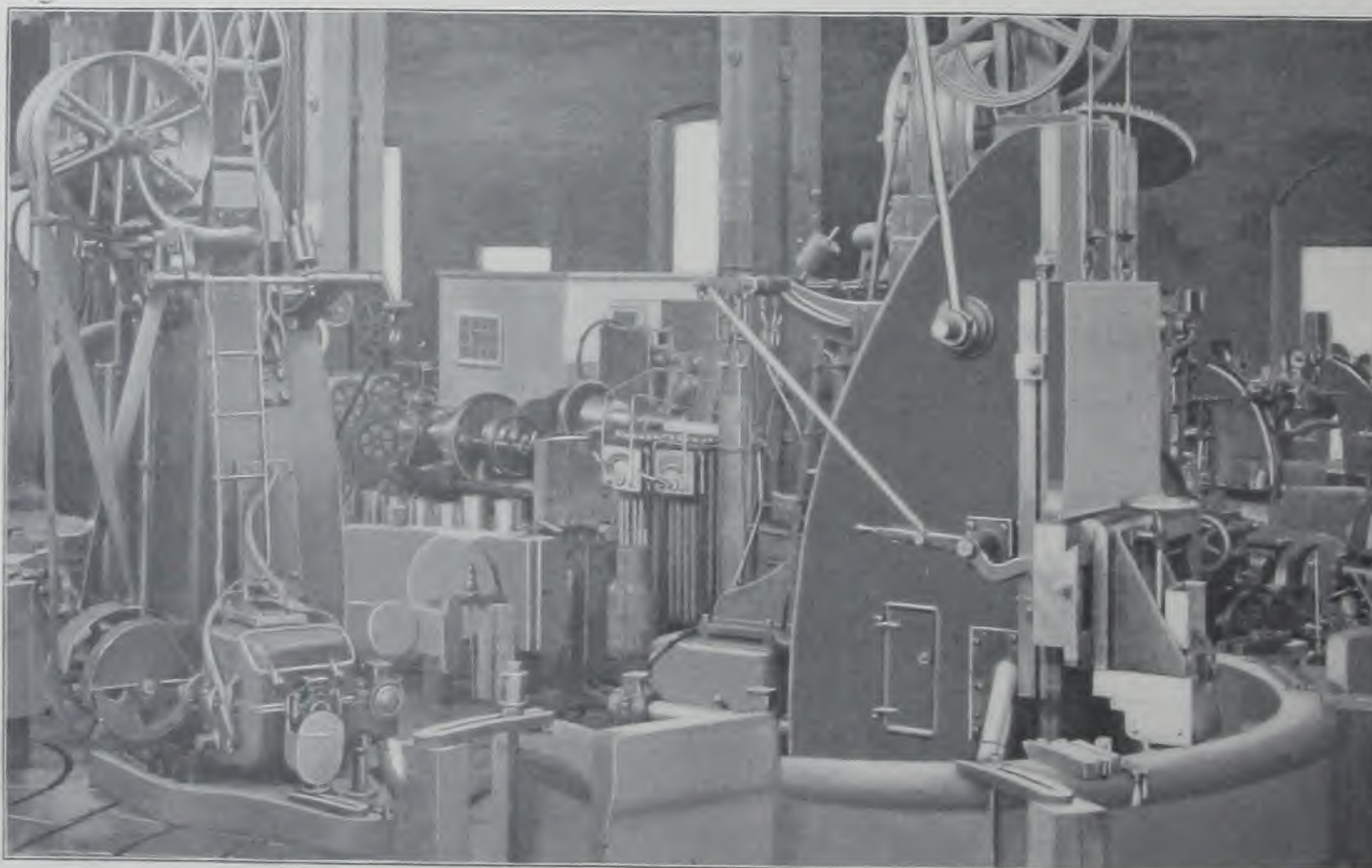


Fifty-inch Ventilating Blower Direct Connected to General Electric
Company's Variable Speed Motor

GENERAL ELECTRIC COMPANY



Vertical Boring Mill with General Electric Company's Variable Speed Motor

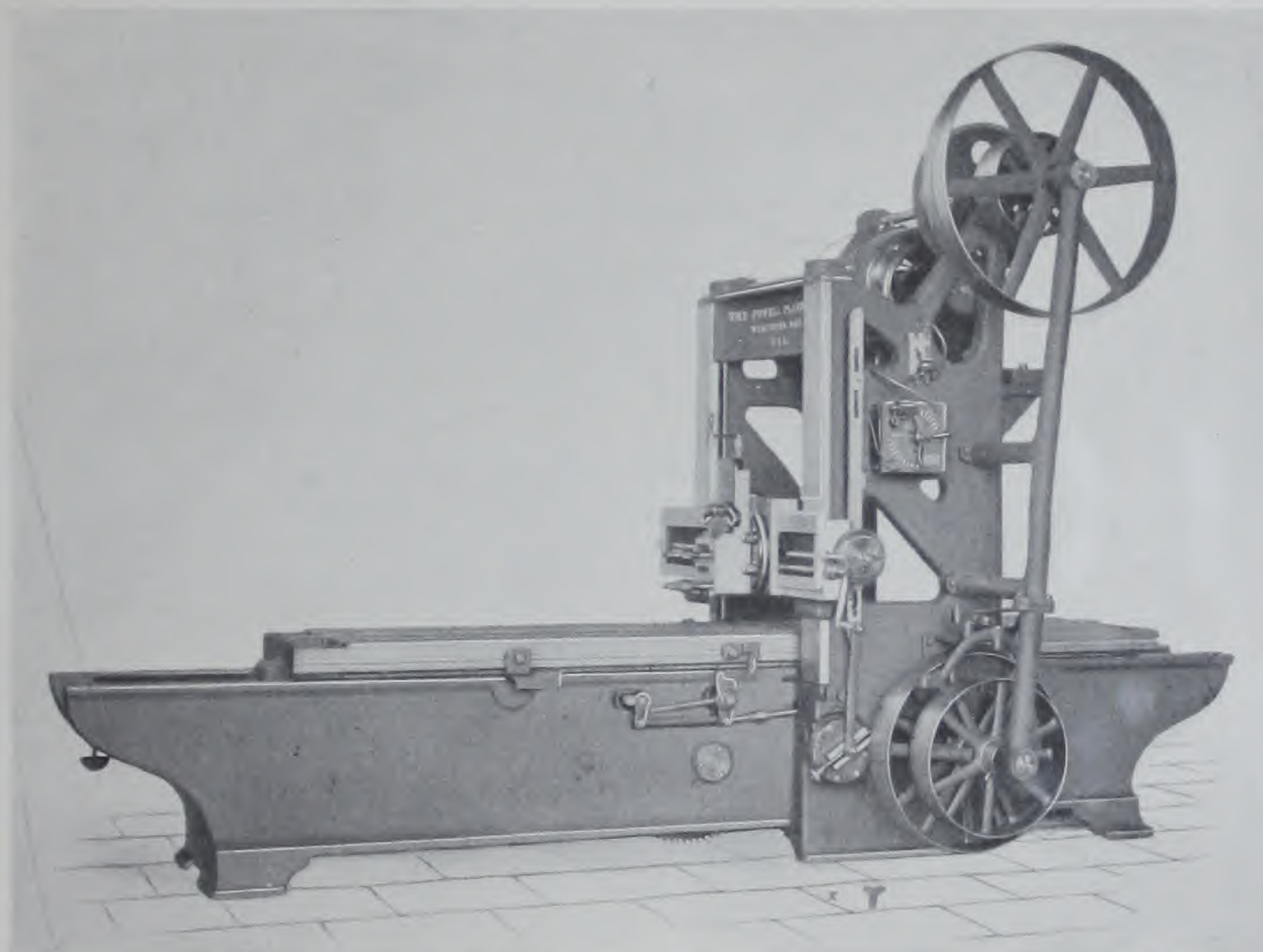


Portable Slotting Machines Driven by General Electric Company's Motors

FLEXIBILITY OF THE ELECTRIC SYSTEM

FIRST cost and operating expense are not always the grounds of final decision in the selection of a power system.

Flexibility is of extreme importance, and in this respect, the electric system is superior to others; for by its use provision can be made for unlimited enlargements in capacity, and by avoiding such inefficient devices as crossed belts and bevel gears, high economy may be maintained.

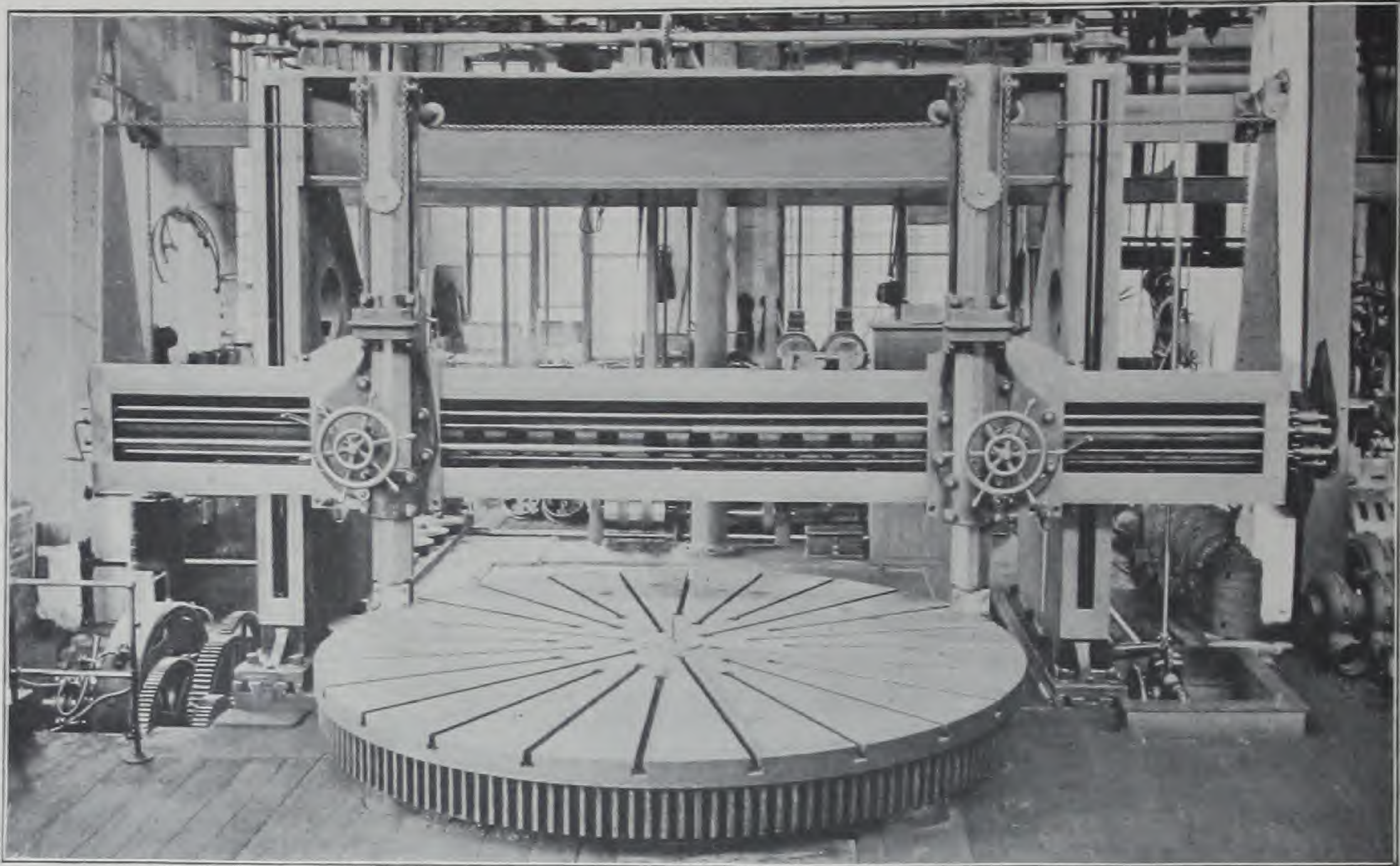


Planer with General Electric Company's CE Motor

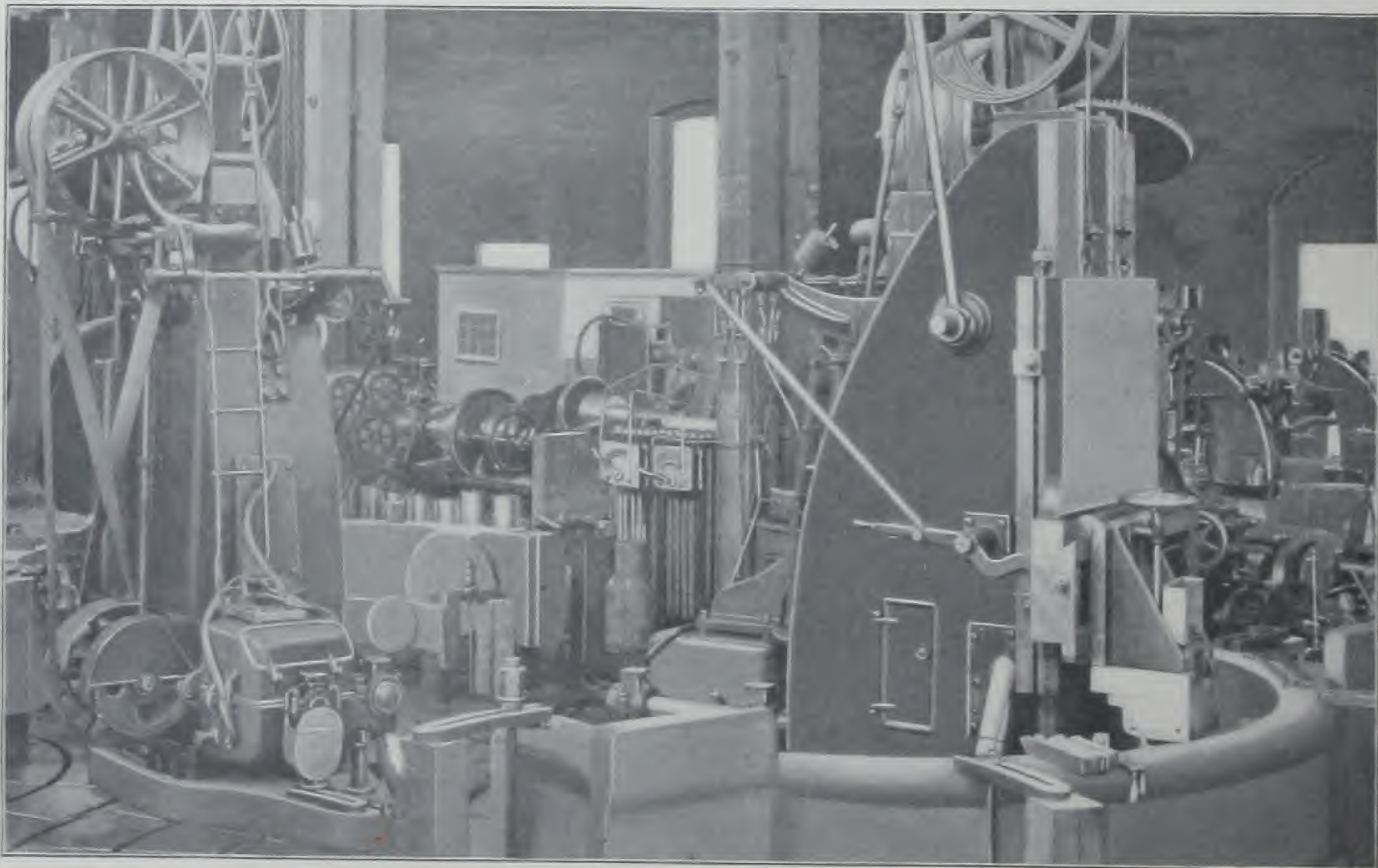
When electricity is used, the designing engineer is not hampered in arranging the buildings in large plants by any difficulties due to transmitting power. The location of the buildings may be determined by considerations of fire risk, storage capacity, accessibility, light, and rapidity of handling the product; and the machinery may be distributed over as large an area as is convenient. An increase in the capacity of an electrically operated plant does not involve tearing out and replacing a long line of shafting, as would be the case if mechanical transmission were employed. It simply means an additional motor.

Two systems are in general use for the application of electric power to machinery: first, a motor is directly connected to each individual machine to be driven; and, second, a motor is arranged to drive two or more machines by means of countershafting. While for most installations the first method is undoubtedly the ideal one, in some cases, especially where electricity replaces steam, the second may be desirable.

GENERAL ELECTRIC COMPANY



Vertical Boring Mill with General Electric Company's Variable Speed Motor

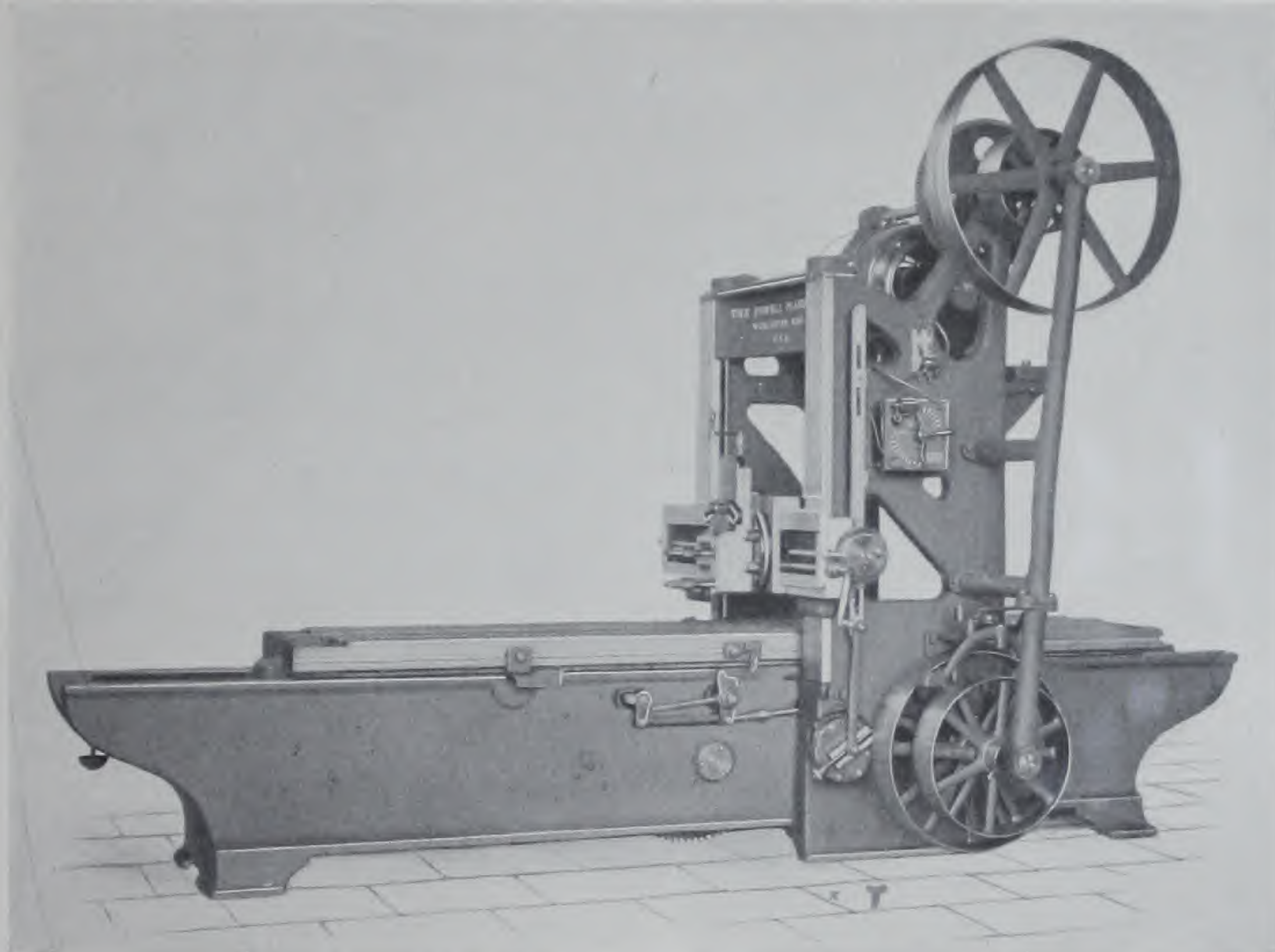


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Planer with General Electric Company's CE Motor

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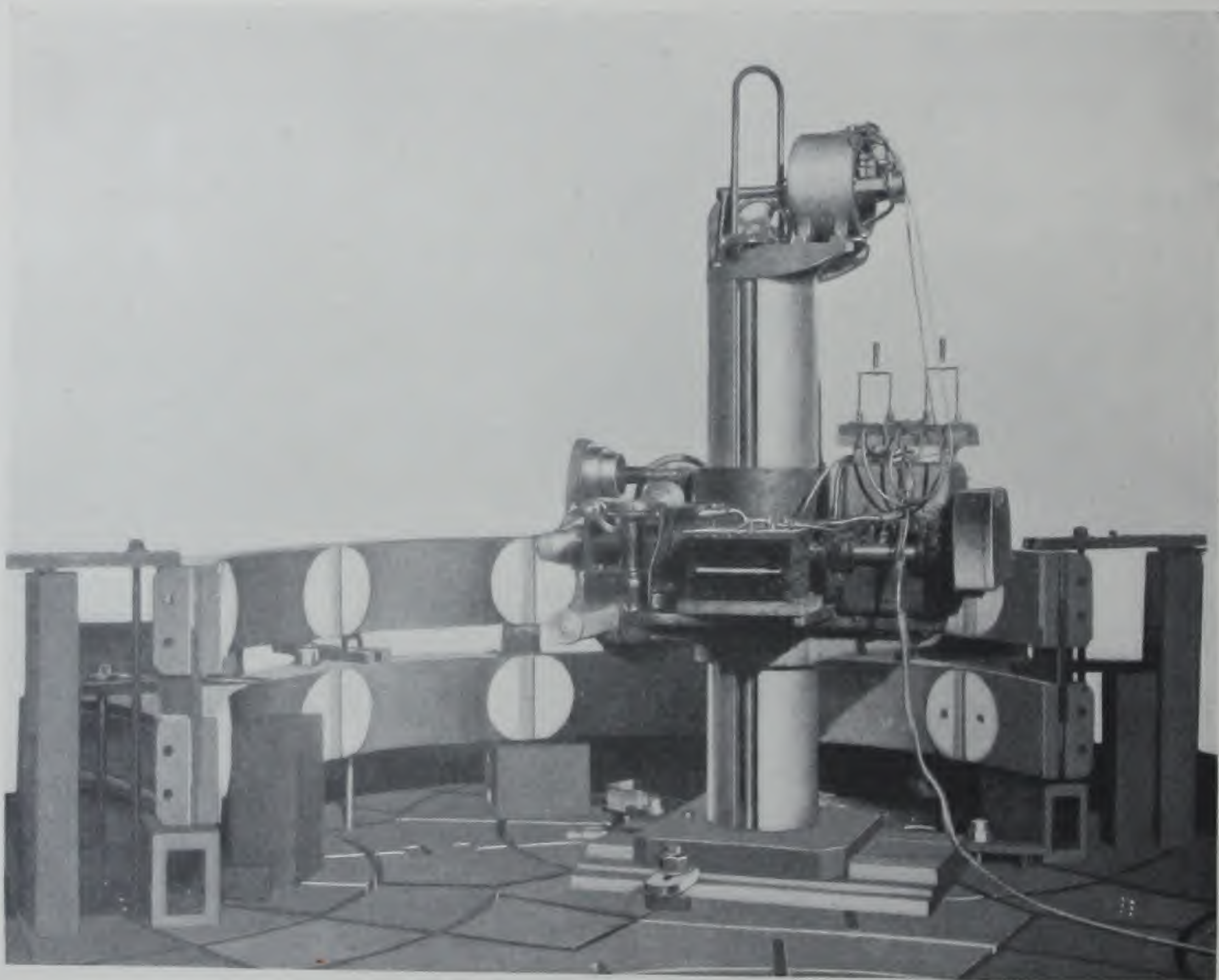
THE MEASUREMENT OF POWER

ANOTHER feature of an electric installation invaluable to the intelligent management of any works is that the power taken by any electrically driven tool or shop is shown by the electrical measuring instruments at all times or can be automatically recorded for future reference.

By no other means can power be so exactly and conveniently gauged, and electric motors are now frequently sold to be used as power dynamometers.

The power required to drive nearly all kinds of tools, as given by their makers, has been found to be extremely inaccurate. This result is natural, as the only available method of measurement was to obtain the indicated horse-power of engines driving an entire shop with its shafting and belting, and divide the total power, largely by guess, among the different tools.

The electric system permits of an intelligent and accurate supervision of the power consumption and indicates where savings may be effected.



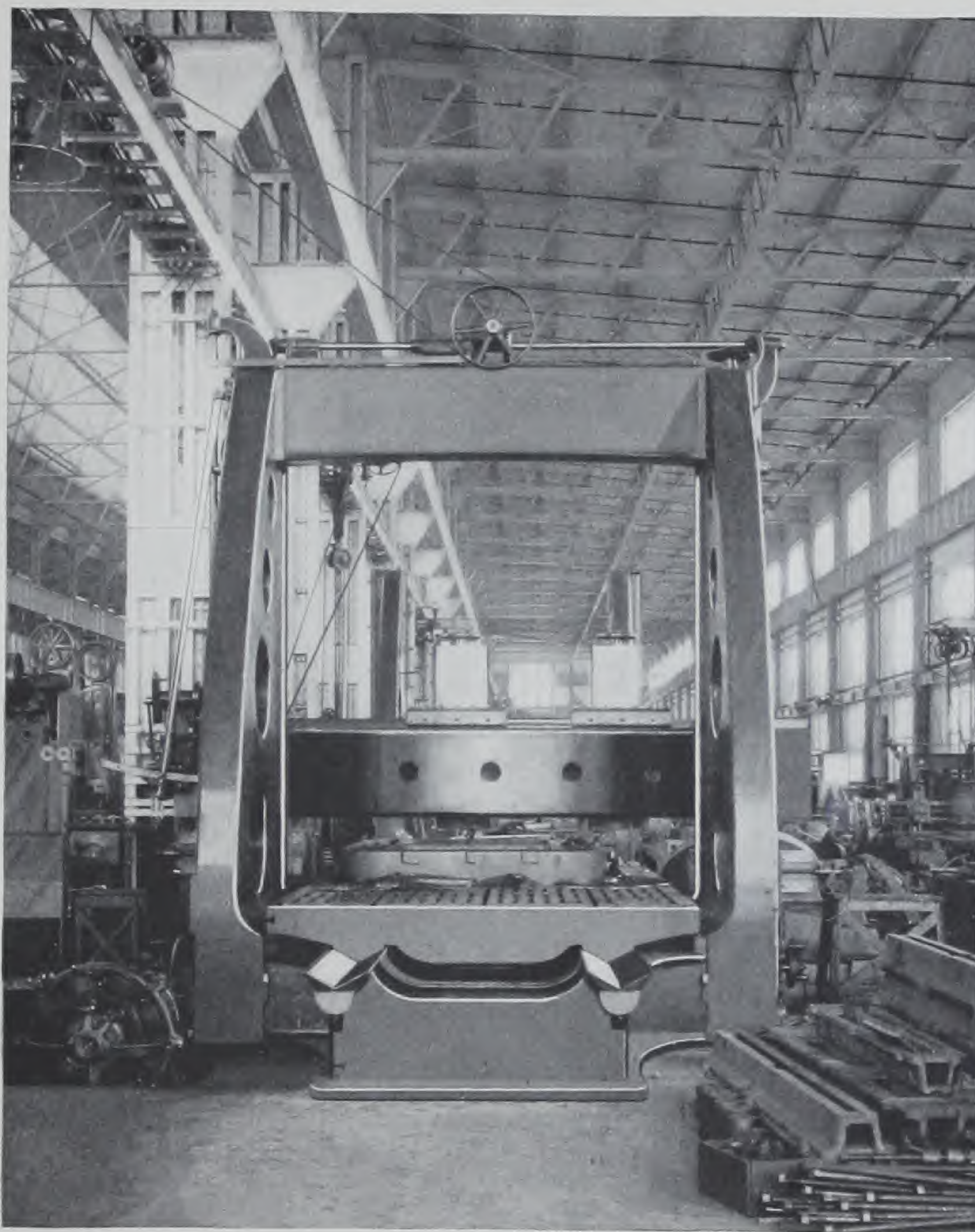
Portable Boring and Drilling Machine Operated by General Electric Company's Motors

SAFETY AND RELIABILITY

THE safety of electric power with modern generators, motors and appliances cannot be equalled by any other system. The reduction in the amount of moving machinery contributes largely to the prevention of accidents, and the voltage used in factory plants need not be high enough to be dangerous either as a fire risk or to life. On the other hand the danger due to numerous moving pulleys, belts, gears and other requisites to a mechanical drive is too well known to require any comment.

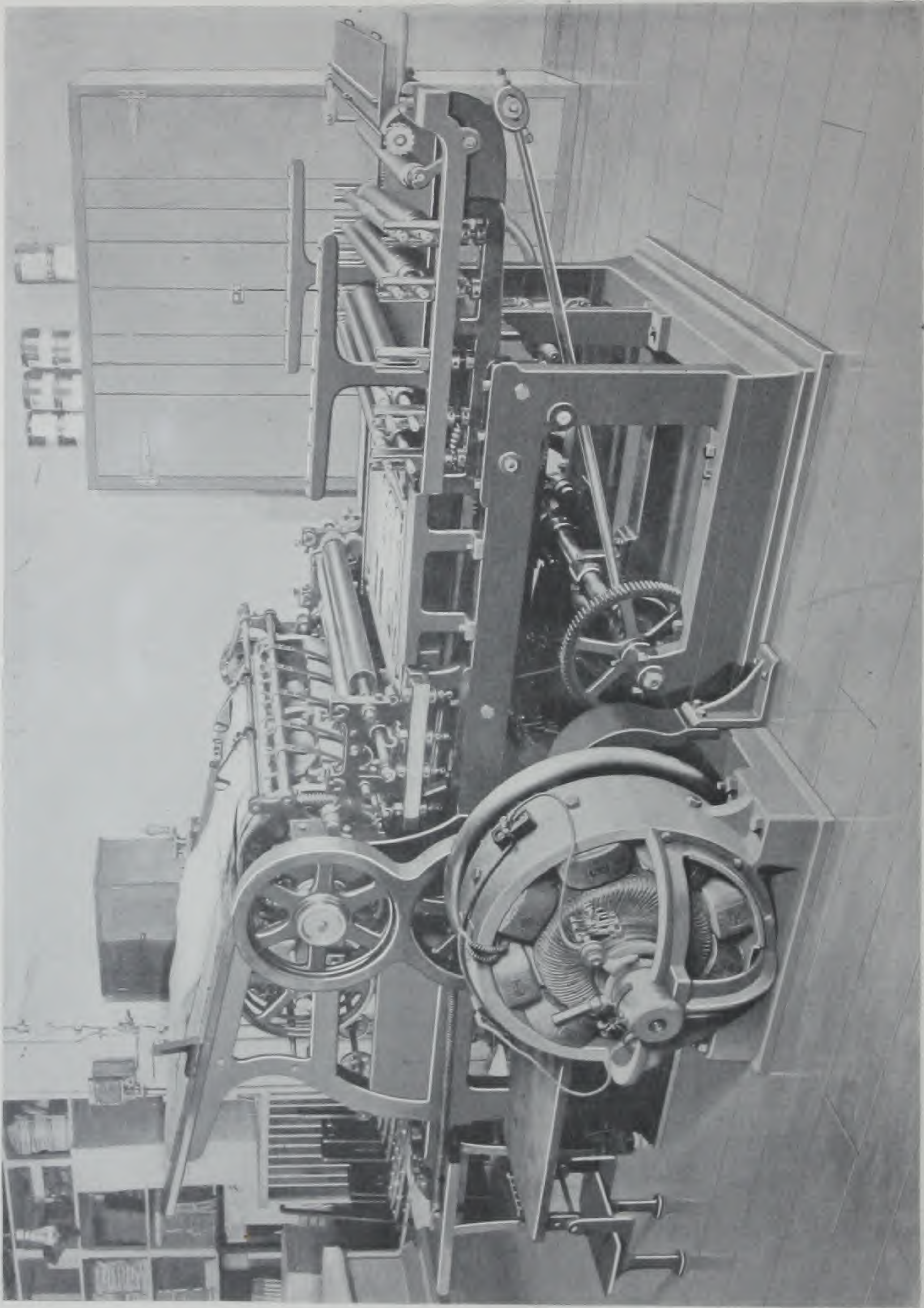
In view of the present perfection of electric generators, motors, and transmission lines, no objections can be offered to the electrical equipment of factories on the ground of unreliability. As usually constructed, a generator or motor has but two bearings and a single shaft which carries the only moving parts of the machine. Wear is, therefore, reduced to a minimum and confined to readily replaced parts. On commutating machines, the use of carbon brushes has eliminated commutator troubles, and such machines will operate continuously for long periods with but little attention. If care is taken to install electric machinery of sufficient capacity for the work, no interruption to daily operation should occur.

Since the transmission lines involve no mechanism or moving parts, there is no wear and deterioration is negligible.



Twenty-one Foot Planer with General Electric Company's Direct Connected Motor

GENERAL ELECTRIC COMPANY



TWO REVOLUTION CYLINDER PRINTING PRESS WITH DIRECT CONNECTED GENERAL ELECTRIC COMPANY'S VARIABLE SPEED MOTOR

INCREASED OUTPUT

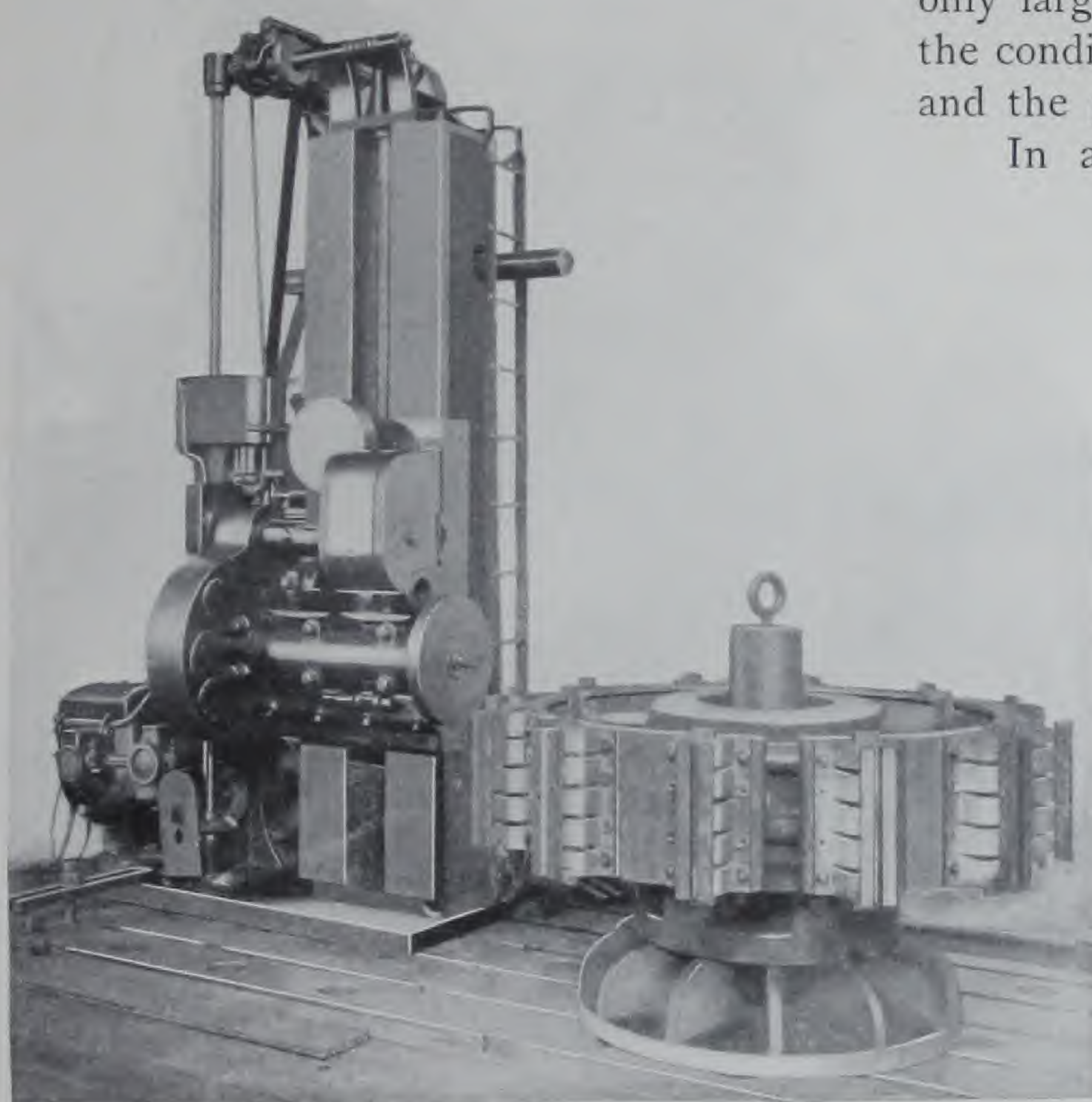
EXPERIENCE has shown that the substitution of an electric for a mechanical system of driving machinery very materially increases the output. This result is due to the remarkably steady speed of the electric motor when built for constant speed and the exact adjustment of speed when speed variation is required.

In a transmission by belting, each belt has more or less slip, and as the power usually passes through several belts, the cumulative loss of power and speed is not only larger but constantly varies with the condition and tension of the belts and the power transmitted.

In an electric transmission, the speed regulation of each motor is practically that of the engine which supplies it with power and is therefore extremely close.

There is a limit to the speed at which any machine can be successfully run, and if there is a variation in speed, the maximum speed must never exceed this limit, or the tool will be damaged and the quality of the product lowered. The greater the variation in speed, the slower must be the average speed and the less the output of the machine.

The constant speed of the



Portable Milling Cutter with General Electric Company's Motor

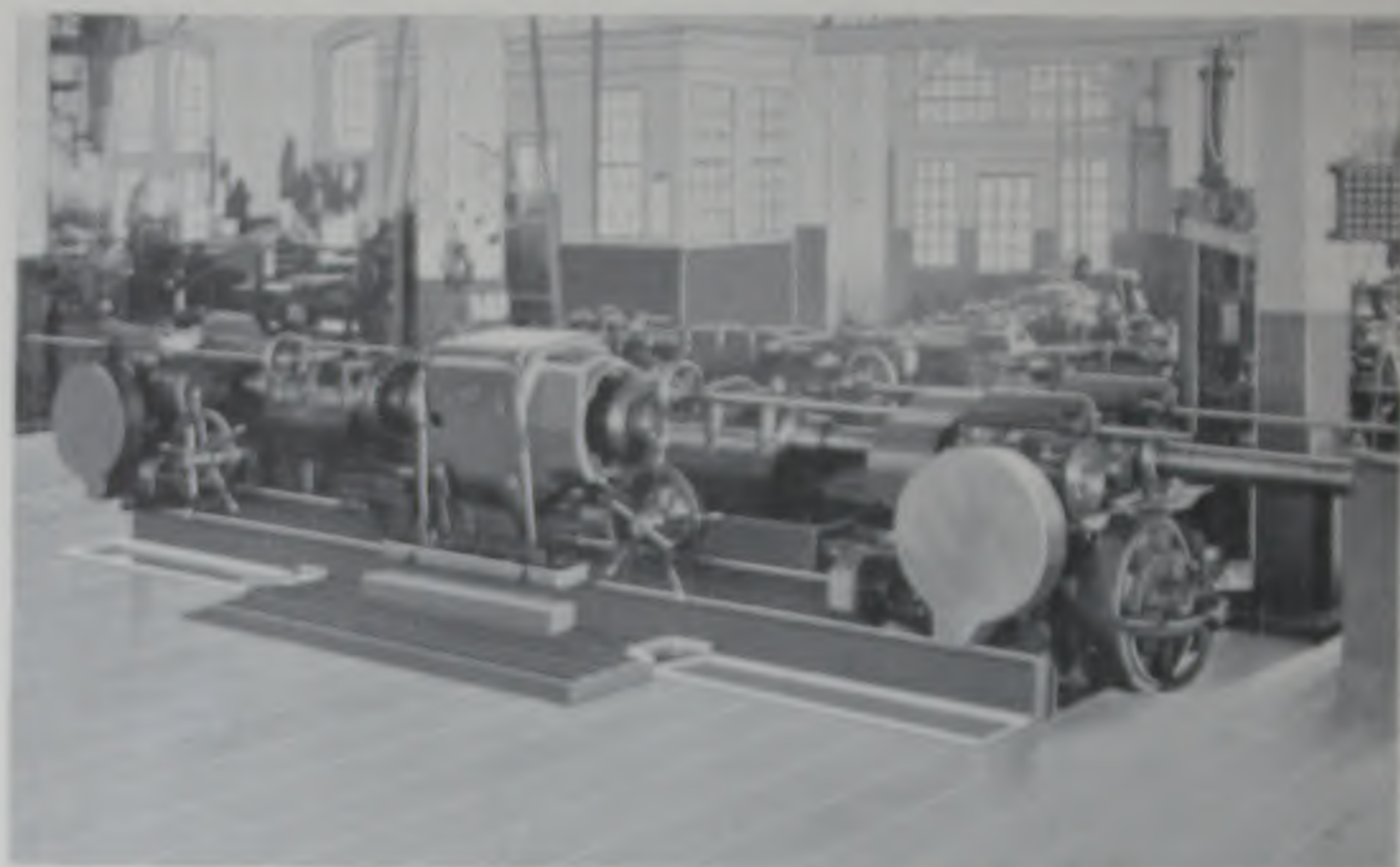
electric motor permits tools driven by it to be run constantly at their maximum speed.

Where machines must run at various speeds, the usual practice is to employ stepped cone pulleys and changeable gears. The speeds obtained in this way are few in number and, therefore, if a wide range of speed is necessary, the different speeds must be far apart.

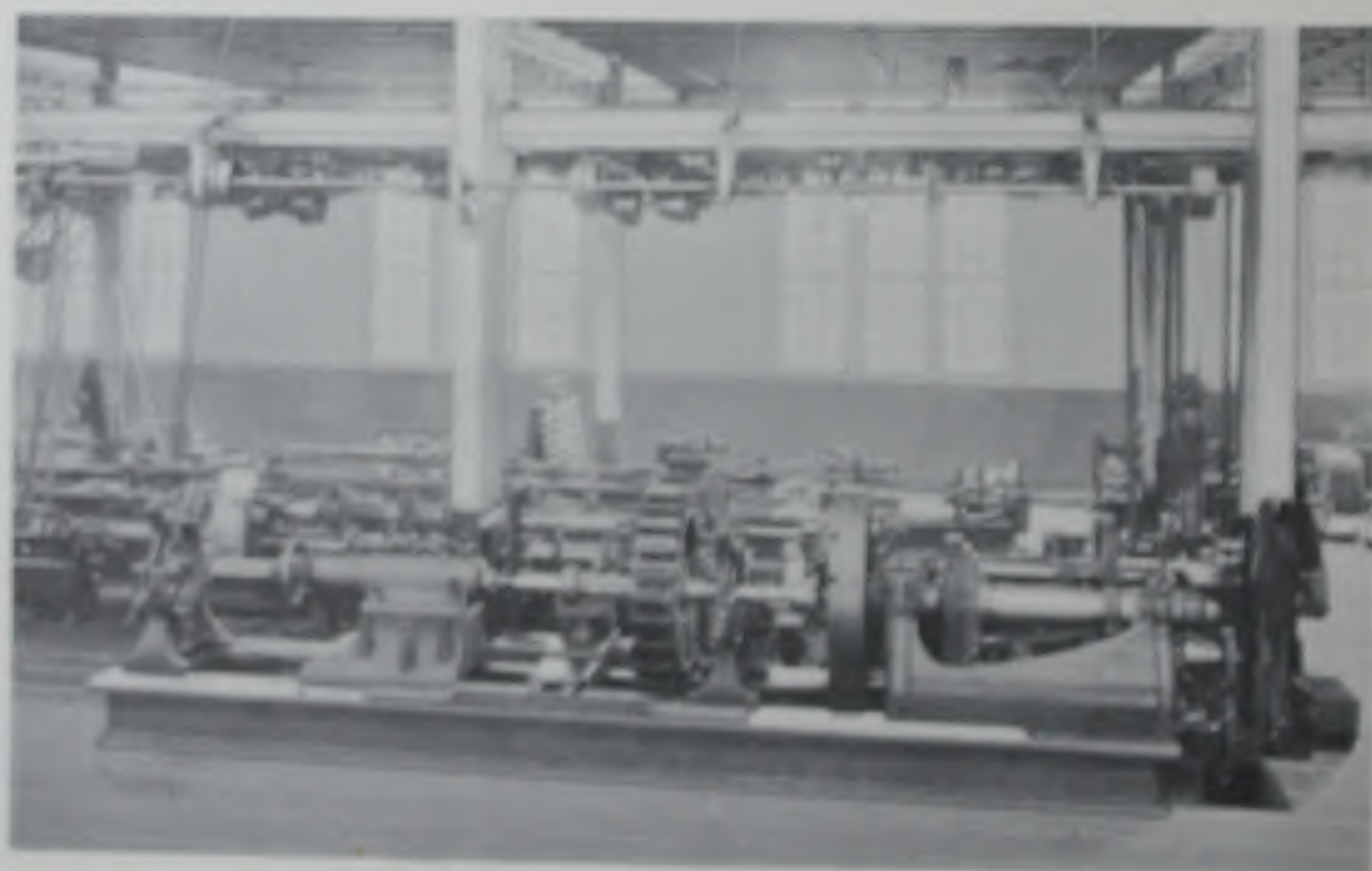
The minimum speed change of lathes, for instance, is usually from 30% to 100%. If the speed with one combination of gears and pulleys is a little too high, it must be reduced to the next lower speed, 30% to 100% lower, with a loss of output nearly equal to the reduction in speed.

If power is furnished by a variable speed electric motor with a range sufficient to fill in between the mechanical steps, the tool may be driven *always* at the highest possible speed and maximum production. This increased production is in many cases so great as to fully justify the installation of an electric system, even if there were no other advantages to be obtained.

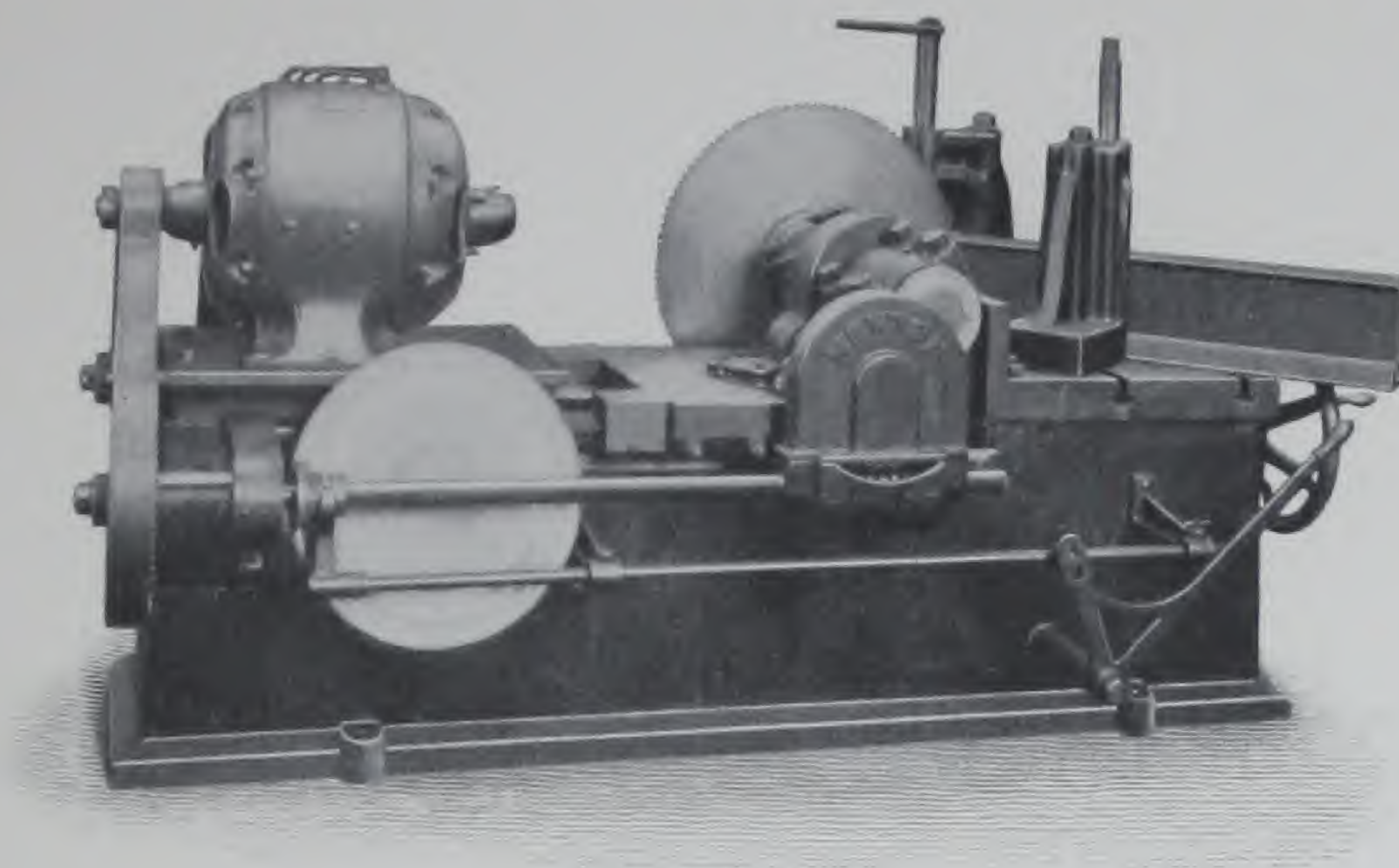
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Railway Motor Testing Mills with Direct Connected General Electric Company's Motors



Lathe Driven by General Electric Company's Direct Connected Motor

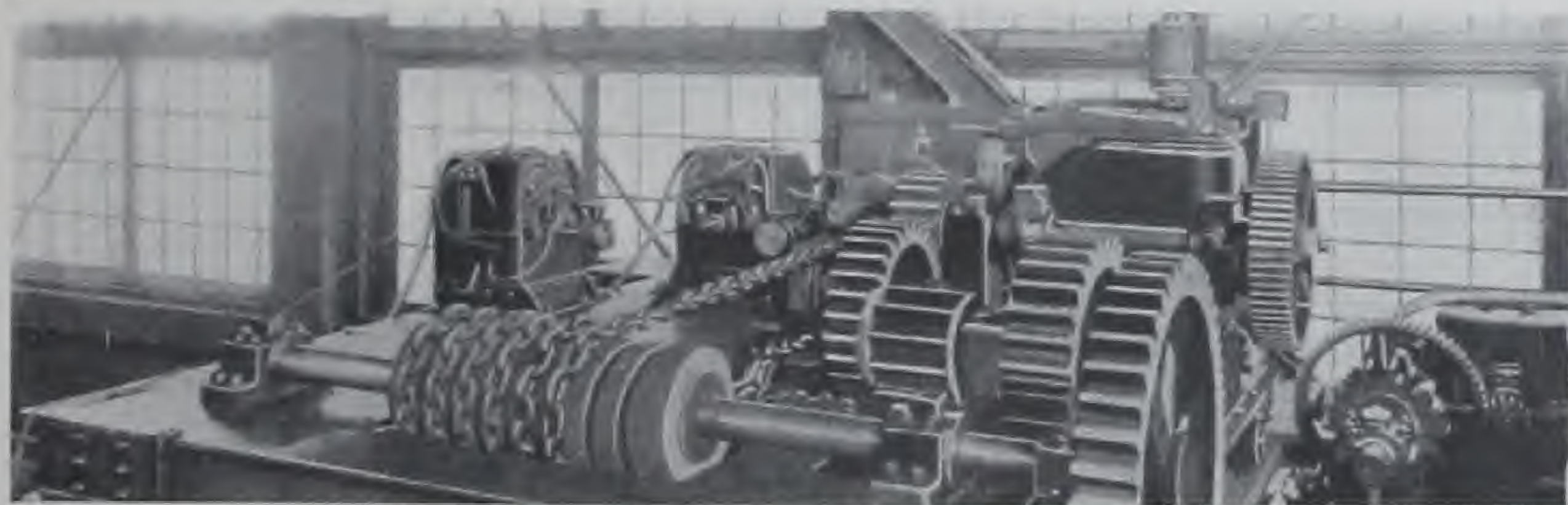


Cold Saw with General Electric Company's CE Motor

ECONOMY OF TIME AND LABOR

ALL that has been said regarding increased output, of course, also means saving of labor, as the increased production is per man as well as per machine.

An extremely important saving of labor, however, is in the better organization permitted by the electric system.



time and labor in handling.

Further, the ease with which motors may be controlled at any distance from the operator permits one man in many cases to run several motors.

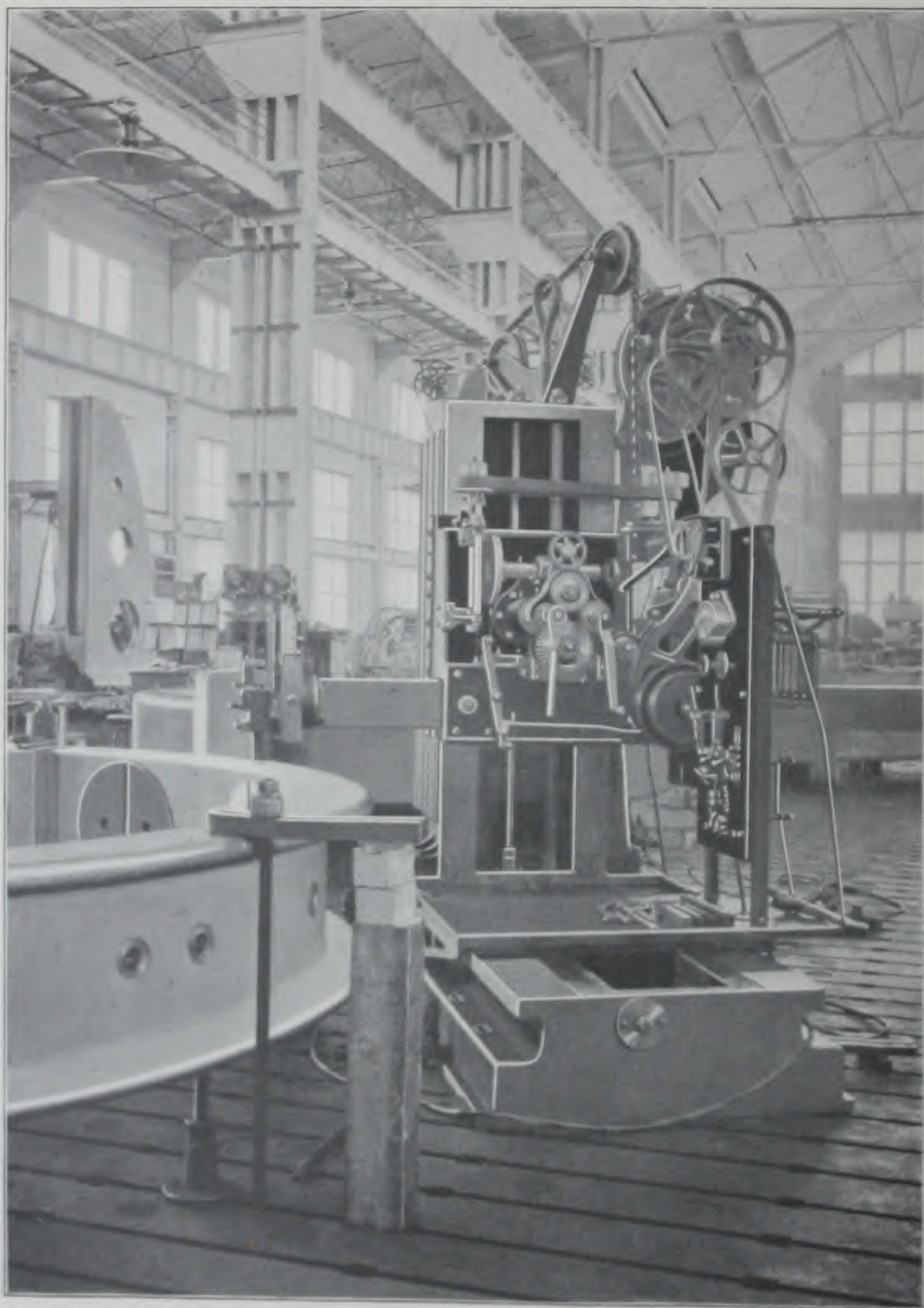


Each tool with its motor may be considered as complete in itself and may be located where its work will continuously come to it in the natural sequence of operations and with the minimum loss of

The best instance of this arrangement is in the modern electrically equipped rolling mills, examples of which are shown in the accompanying illustrations. One man surrounded by a dozen or more operating levers controls every motion of the steel from the ingot furnace to the completed rail.

In this case, not only has every motor replaced a man, but the work is done better and more quickly than formerly.

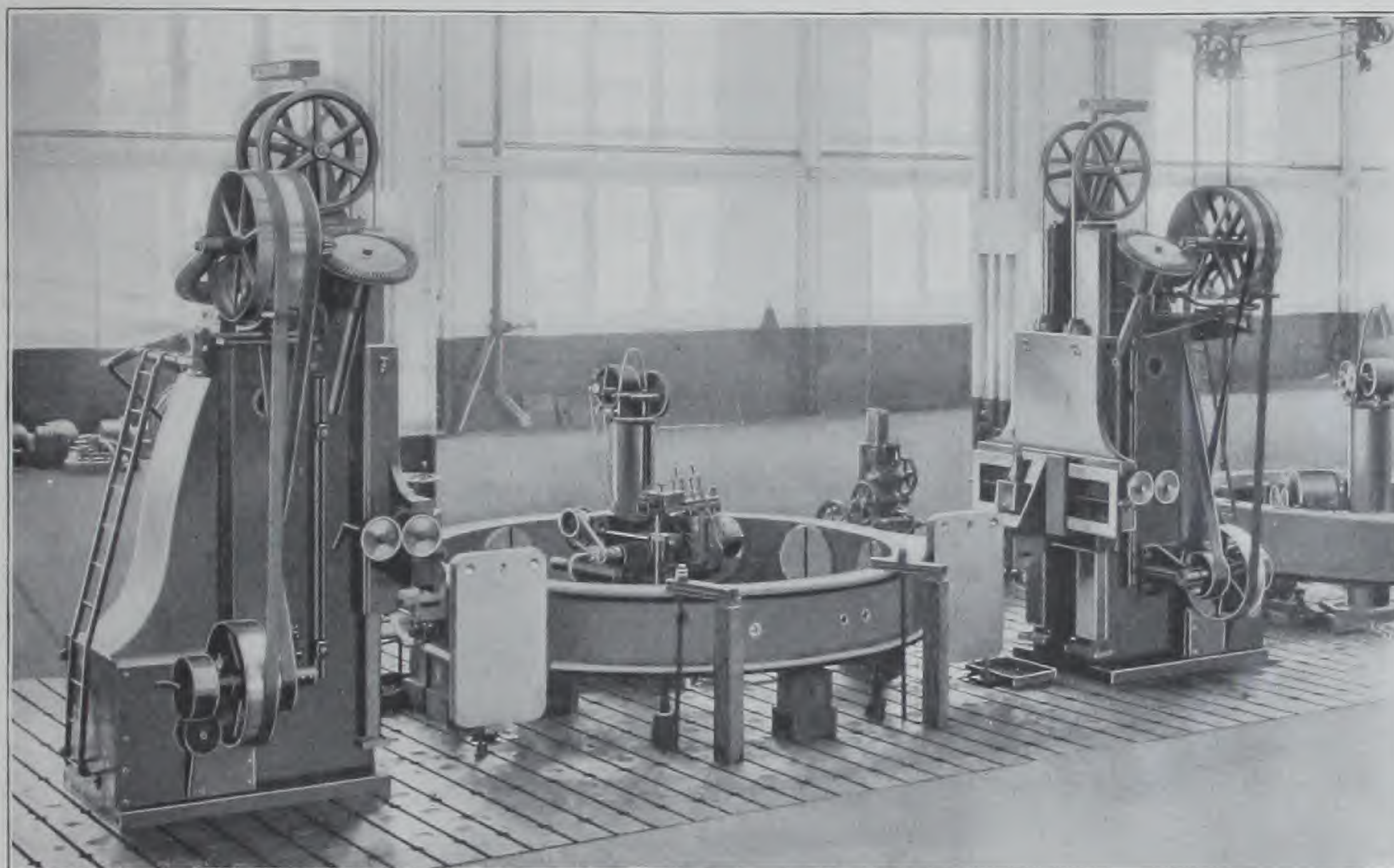
GENERAL ELECTRIC COMPANY



Portable Shaper, Milling, Boring and Drilling Machine with General Electric Company's Variable Speed Motor

PORTABLE TOOLS

IN a new installation, it is almost invariably best to drive all machines consuming, say, 5 H.P. or over by individual motors. The expense involved is greater than that of one larger motor for several machines, but with individual motors the speed can be varied according to the work to be done. The different speeds required by nearly all machines under different conditions can be obtained by means of direct connected motors and controlling rheostats.

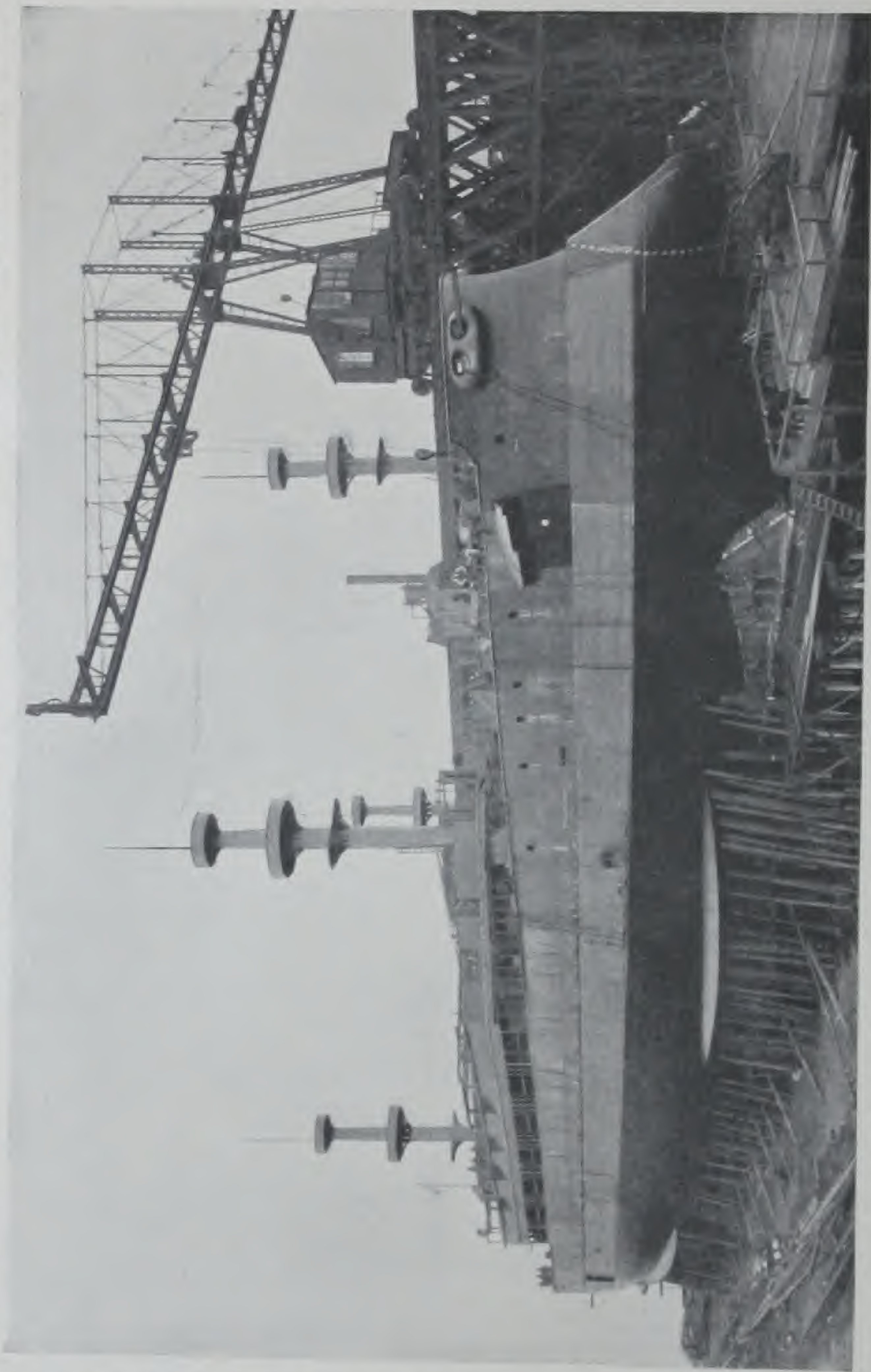


Portable Drill Press and Portable Slotters Driven by General Electric Company's Motors

Another important advantage of this arrangement is that it makes the tool and its driving motor a self-contained unit, which may be picked up by the traveling crane and deposited in any part of the building.

A machine with attached motor may be operated in any place to which a wire can be run, and the plan of moving the tool to the work in place of moving heavy castings from tool to tool is now revolutionizing the method of handling heavy machine work in progressive plants. The work may be lined up once for all, and portable electric shapers, drill presses and boring mills carried to it. In fact, several different kinds of tools may work on a casting at one time, thus saving much time and labor.

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Cantilever Brown Crane at Newport News with Two 60 H.P. General Electric Company's Motors—Battleships "Kearsarge" and "Kentucky"

CRANES AND TRAMWAYS

PROBABLY in no field has electric power come into more general use and been of more service in saving labor and expediting production than in factory transportation.

Overhead traveling cranes operated by electric motors are a necessity for the rapid and safe handling of all heavy work and for moving the tools themselves when portable.

In order that the overhead cranes may reach every tool and all parts of the workshop, there must be no overhead obstructions, and here again we find another reason for the direct connected electrically driven tool which requires no overhead pulleys and shafting.

Electric surface tramways also are indispensable for handling materials out of doors and in some cases are desirable inside of factory buildings.

They are used to bring raw materials from the railway station or wharf, transport the product between the buildings at various stages of completion and finally to deliver it finished to the nearest shipping point.

The jib crane shown in the above illustration is the largest of its kind ever built.

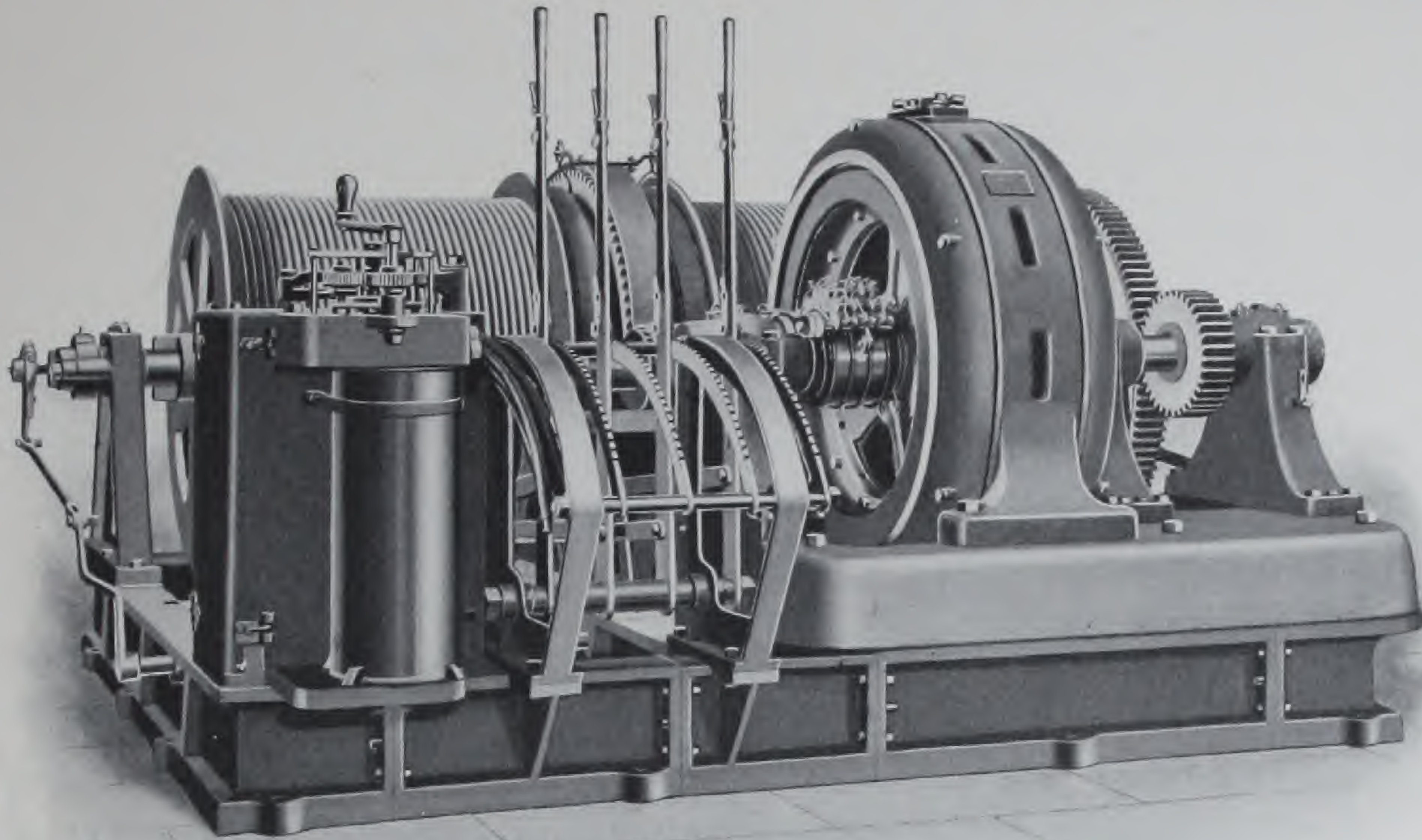


140 Ton Derrick at Newport News Equipped with Five 140 Horse-power and Two 20 Horse-power General Electric Company's Motors

GENERAL ELECTRIC COMPANY



Raising Left Bridge over the North Branch of the Chicago River at North Halsted St., Chicago.
Operated by General Electric Company's Motors



Double Drum Electric Hoist Direct Connected to General Electric Company's Induction Motor

FOR INTERMITTENT SERVICE

MANY other applications of electric power such as hoists, elevators, drawbridges, transfer tables, etc., are like cranes and tramways in that they are not in continual use but may be wanted at any time. For such service, the electric motor is particularly well adapted. It is always ready, consumes power only in proportion to the work it is doing and requires no power when idle. With all other forms of transmission, belts, shafts, ropes, steam or compressed air, the friction, condensation or leakage losses are nearly constant and much power is being consumed whether useful work is being done or not.



Transfer Table Equipped with General Electric Company's Motor

The more intermittent the work, therefore, the greater the saving effected by the use of electric power.

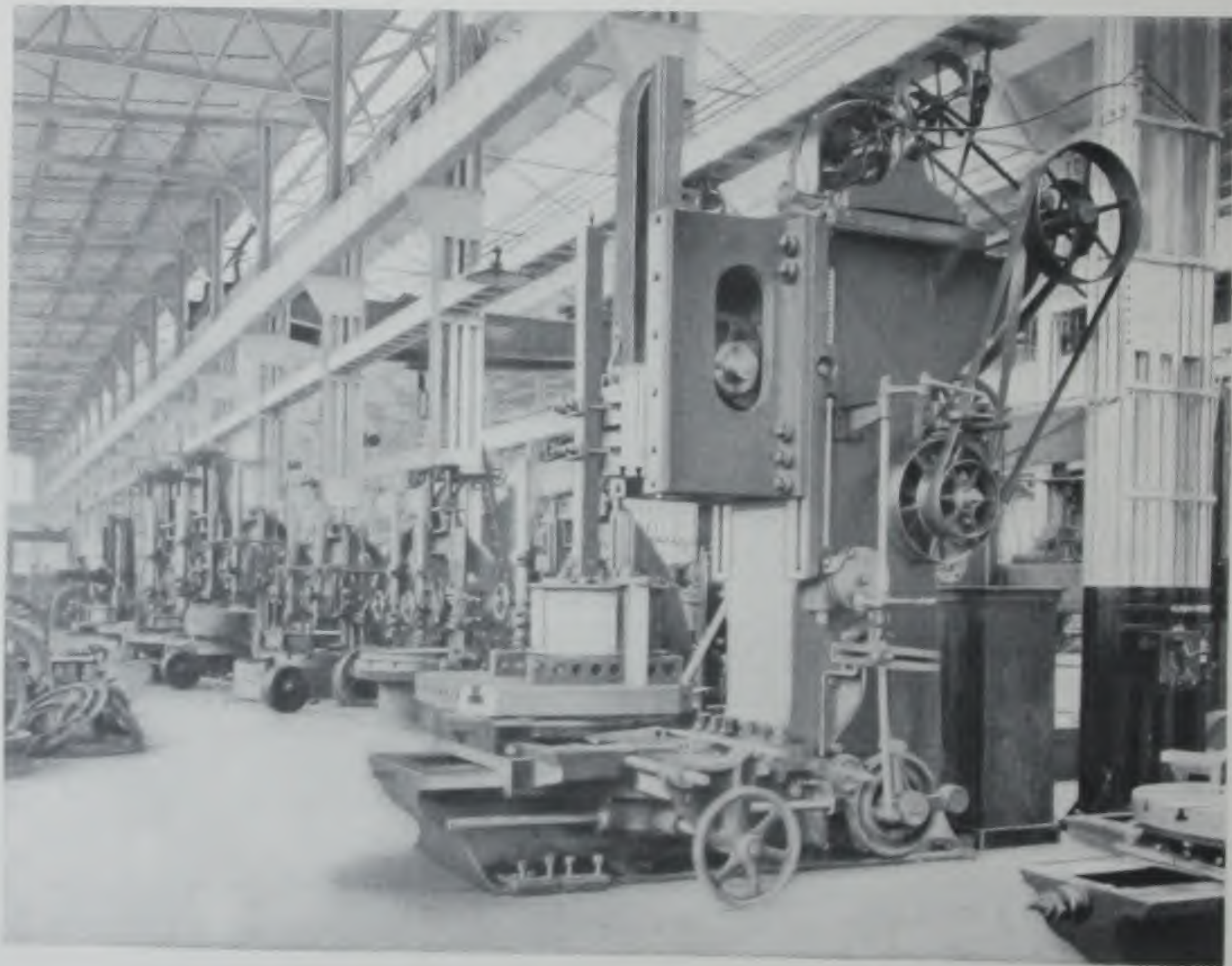
LIGHT, AIR AND CLEANLINESS

NOT the least desirable feature of the electrical operation of a factory is the better hygienic condition of the employes. The same power which drives the machinery gives the only artificial light which does not vitiate the air. Arc lamps for extensive areas or incandescent lamps for fine work furnish the only satisfactory illumination for the workroom.

The almost complete freedom of the electric system from shafts, bearings and belts is important, as they not only cut off the light but stir up dust and throw oil.

Cleanliness is always to be desired and is essential to many industries, such as textile mills and printing establishments. There it gives an immediate return in the better quality of the output.

The conditions under which men labor cannot but affect their capacity for work and we believe that there is no industry in which better light, purer air and greater cleanliness will not be reflected in an increased production of goods of better quality.



Fifty-four Inch Slotting Machine Driven by General Electric Company's Motor



GENERAL ELECTRIC COMPANY

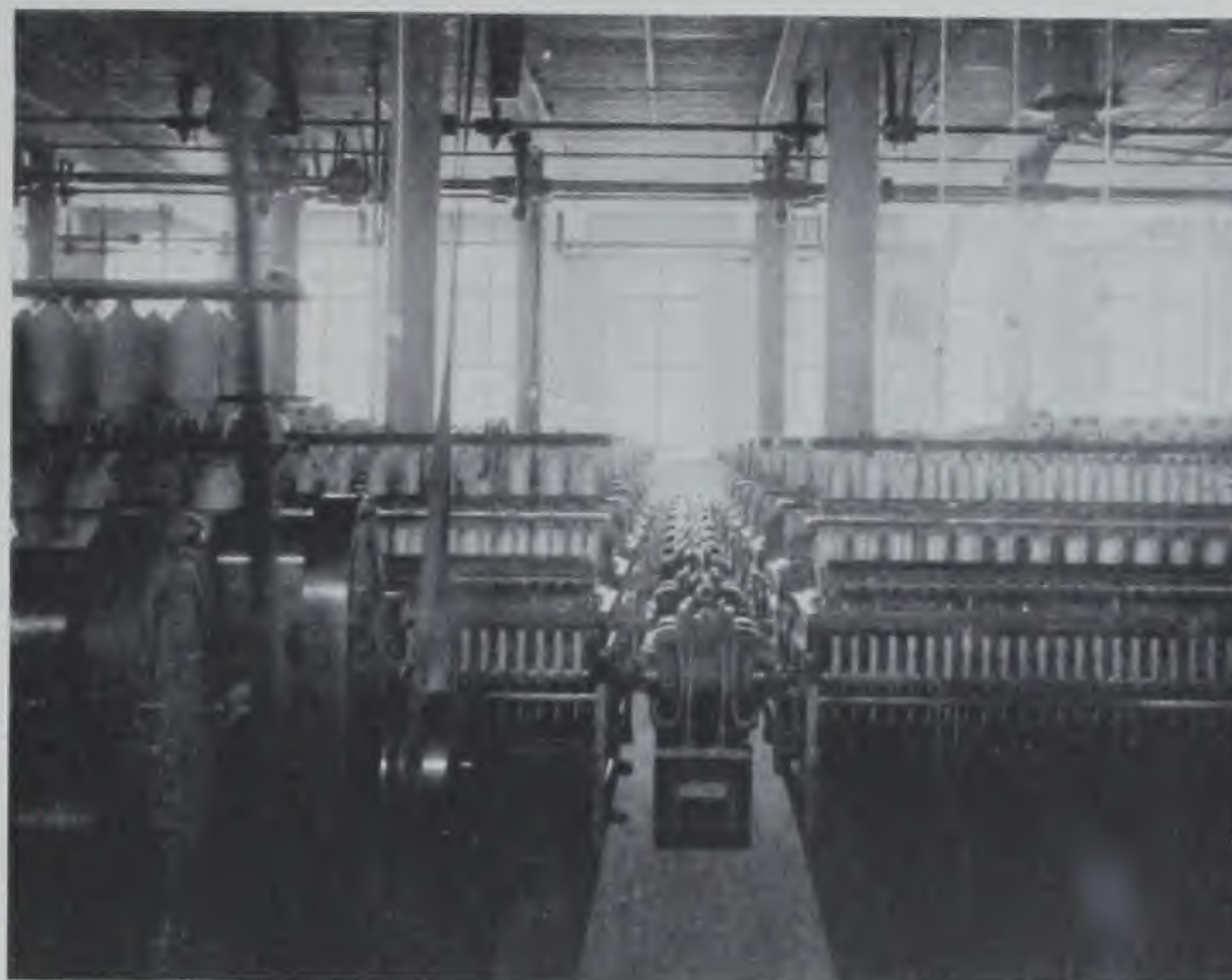


A SPINNING ROOM OF THE PELZER MANUFACTURING COMPANY, SHOWING GENERAL ELECTRIC COMPANY'S INDUCTION MOTORS

THE MANUFACTURE OF TEXTILE FABRICS

FOR the manufacture of textile fabrics the power must be delivered with absolute uniformity, and on this account, many systems which might otherwise be desirable are entirely inapplicable to this work. In addition to the regularity of electrical power, its cleanliness is an important advantage which is not possessed by any other form of power.

By driving large machines and groups of small machinery by individual motors, little or no shafting or belting is necessary. In addition to the saving of power and other advantages, this arrangement makes it possible to completely shut down any part of a plant without affecting the operation of the remainder. In



Induction Motors Direct Connected to Spinning Frames—Anderson Cotton Mills

large establishments subject to variations in output this feature is most desirable.

The installation of electric power in factories for the manufacture of cloths and woven fabrics invariably increases the output, improves the quality of the product, and effects a very noticeable economy.

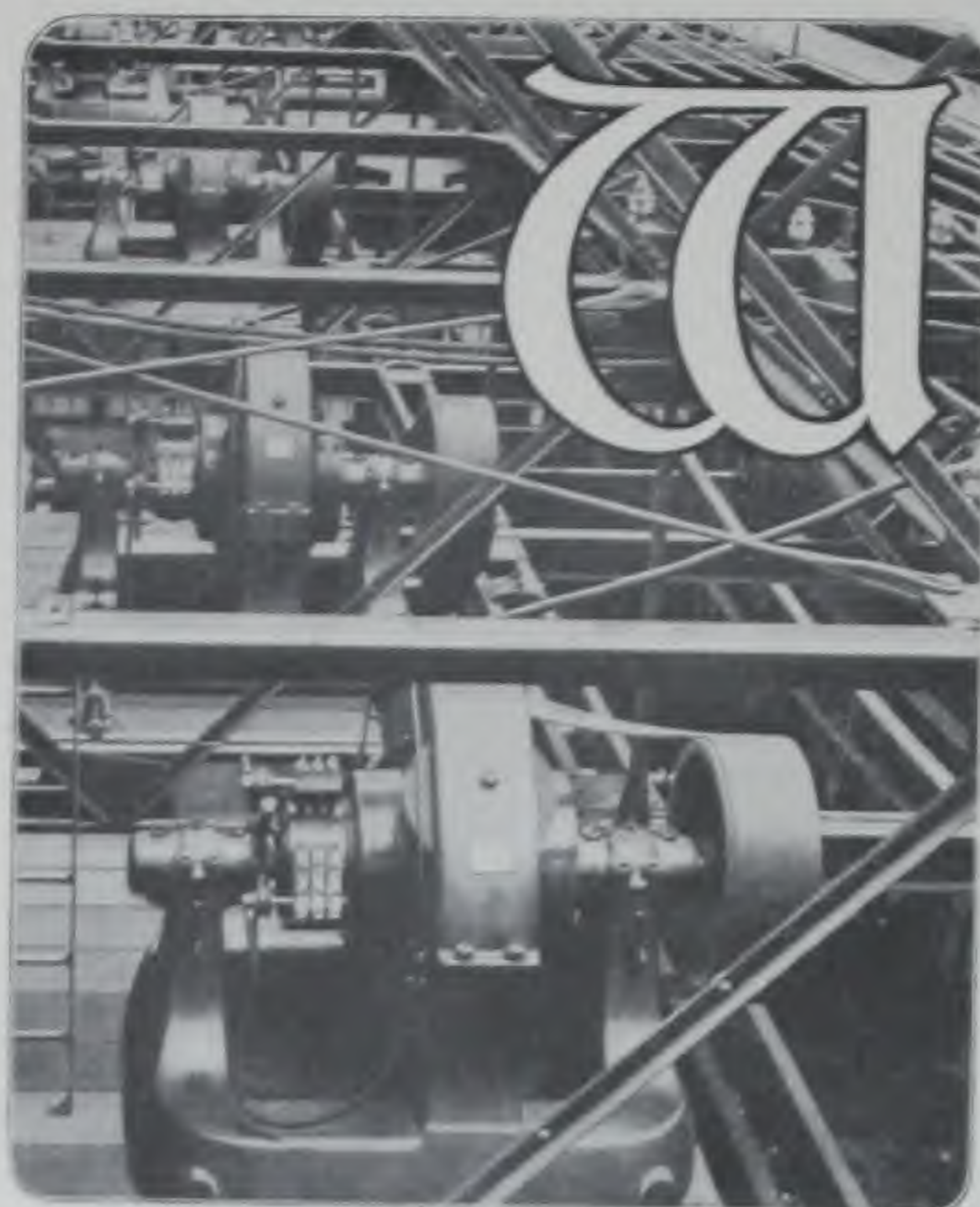
Manufacturers are recognizing these advantages, and there are now over 300 motors in use in textile mills, aggregating over 25,000 horse-power.

The following are some of the manufacturers of textile fabrics who have installed General Electric Company's apparatus in their mills:

TREMONT & SUFFOLK MILLS, LOWELL, MASS.
 PELZER MANUFACTURING COMPANY, PELZER, S. C.
 COLUMBIA MILLS COMPANY, COLUMBIA, S. C.
 BOSTON DUCK COMPANY, BONDSVILLE, MASS.
 AMOSKEAG MFG. COMPANY, MANCHESTER, N. H.
 HADLEY THREAD COMPANY, HOLYOKE, MASS.
 WAMSUTTA MILLS, NEW BEDFORD, MASS.
 GRANBY MILLS, COLUMBIA, S. C.
 PALMETTO MILLS, COLUMBIA, S. C.
 ANDERSON COTTON MILLS, ANDERSON, S. C.
 JACKSON COMPANY, NASHUA, N. H.
 WASHINGTON MILLS, LAWRENCE, MASS.
 MANCHESTER MILLS, MANCHESTER, N. H.
 COCHECO WOOLEN MFG. CO., E. ROCHESTER, N. H.
 ARLINGTON MILLS, LAWRENCE, MASS.
 COCHRANE MFG. COMPANY, DEDHAM, MASS.

PONEMAH MILLS, TAFTVILLE, CONN.
 NONOTUCK SILK COMPANY, LEEDS, MASS.
 J. N. STEARNS & COMPANY, ELMIRA, N. Y.
 J. R. WHITE, ELMIRA, N. Y.
 MONTREAL COTTON COMPANY, VALLEYFIELD, Q.
 ORR COTTON MILLS, ANDERSON, S. C.
 LUDLOW MFG. COMPANY, LUDLOW, MASS.
 J. & P. COATS, PAWTUCKET, R. I.
 THE OLYMPIA COTTON MILLS, COLUMBIA, S. C.
 THE COLUMBIA MFG. COMPANY, COLUMBUS, GA.
 SALMON FALLS MFG. COMPANY, SALMON FALLS, N. H.
 BUFFALO COTTON MILLS, UNION, S. C.
 CAPITAL COTTON MILLS, COLUMBIA, S. C.
 SAMPSON CORDAGE COMPANY, SHIRLEY, MASS.
 HASKILL SILK COMPANY, WESTBROOK, MAINE.
 LANCASTER MILLS, CLINTON, MASS.

MACHINE SHOPS



Farrel Foundry and Machine Company

WHEN electric current from a central station is available, a machine shop frequently prefers to buy electric power rather than maintain a steam plant. In very large factories, however, where a great amount of power is required continually, it is usually economical to install a power plant. A machine works which generates its own power is that of the Farrel Foundry & Machine Company, of Ansonia, Conn. Its electric plant consists of two 75 Kw. (100 H.P.) generators, one 65 Kw. (87 H.P.) generator, and nineteen motors, having a total horse-power of 320. All but three of these motors are either 10 or 15 horse-power and run at the slow speed of 300 revolutions per minute. The accompanying illustration shows six motors secured to the roof girders and belted to short line shafting below.

An interesting plant is that of the Buffalo Bolt Works, formerly Plumb, Burdick & Bernard, North Tonawanda, N. Y. In this plant, induction motors are used exclusively and are operated by current from either their own electric plant or from Niagara Falls.

The following is a partial list of machine shops using General Electric Company's motors and generators:

BARNEY & SMITH CAR COMPANY,	DAYTON, O.
CLEVELAND PUNCH AND SHEAR WORKS,	CLEVELAND, O.
C. & G. COPPER COMPANY,	MT. VERNON, O.
HILLIS & JONES COMPANY,	WILMINGTON, DEL.
C. W. HUNT & COMPANY,	WEST NEW BRIGHTON, N. Y.
KING, GILBERT & WARNER COMPANY,	COLUMBUS, O.
LEWIS FOUNDRY AND MACHINE COMPANY,	PITTSBURG, PA.
LUDLOW VALVE MANUFACTURING COMPANY,	TROY, N. Y.
NATIONAL PIPE AND FOUNDRY COMPANY,	SCOTSDALE, PA.
NATIONAL TUBE WORKS,	MCKEESPORT, PA.
NEW CASTLE TUBE WORKS,	NEW CASTLE, PA.
PORT CHESTER BOLT AND NUT COMPANY,	PORT CHESTER, N. Y.
SCHENECTADY LOCOMOTIVE WORKS,	SCHENECTADY, N. Y.
SPRINGFIELD MACHINE TOOL COMPANY,	SPRINGFIELD, O.
THE STANLEY WORKS,	NEW BRITAIN, CONN.
STEARNS ROGERS MANUFACTURING COMPANY,	DENVER, COLO.
TUBULAR RIVET AND STUD COMPANY,	WOLLASTON, MASS.
WELLMAN-SEAYER ENGINEERING COMPANY,	CLEVELAND, O.
ROBERT WETHERELL & COMPANY,	CHESTER, PA.
YORK MANUFACTURING COMPANY,	YORK, Pa.
TIFFANY & COMPANY,	FOREST HILLS, N. J.

TRANSFER AND TURNTABLES

TRANSFER and turntables are most conveniently driven by motors and the economy is evident. If steam propulsion be used, a complete steam plant must be installed on the table and requires constant attendance. If not in constant use, the cost per transfer or turn becomes very large. With an electric motor, no expense is incurred when the table is idle, and the cost per transfer or turn is much lower than when either steam or hand power is used. Many railroads are putting in electric turntables, and careful investigation shows that the cost per turn by electricity is from 30 to 50 mills, while with hand power it is from 10 to 12 cents. The "Railroad Gazette" of Oct. 14th, 1898, says in an editorial on this subject: "Looking at the matter from every standpoint, whether the turntable is now in use or if a new one is to be built, there should be a saving by the introduction of electricity for the driving power when the number of engines turned each day is large. Just what the saving in each case would be can be easily figured when the facts are fully known."

Electric transfer tables have been installed by:

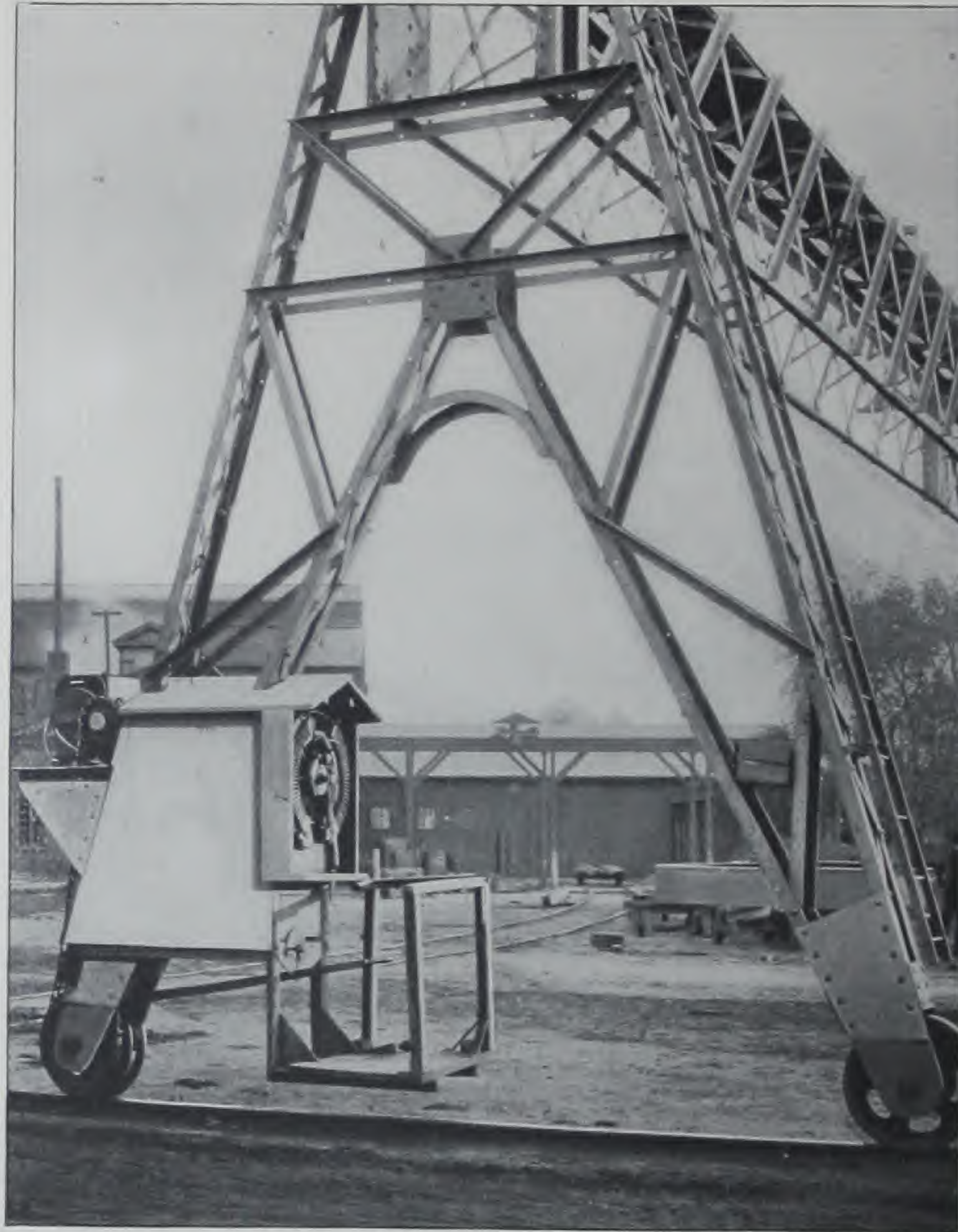
BARNEY & SMITH CAR COMPANY,	DAYTON, O.
THE JOHNSTON COMPANY,	SOUTH LORAIN, O.
C. B. & Q. R. R.,	AURORA, IND.
SOUTHERN PACIFIC R. R.,	SACRAMENTO, CAL.
L. N. H. & C. R. R.,	LAFAYETTE, ILL.
ERIE R. R.,	JERSEY CITY, N. J.



Electrically Operated Turntable at Jersey City, N. J.

IRON AND STEEL WORKS

THE Camden Iron Works, Camden, N. J., is one of the many iron and steel works equipped with electricity. The generators and motors are of the General Electric Company's direct current type, wound for a potential of 250 volts. The motors are used for a great variety of purposes. One furnishes motive power to a trammel



Trammel Overhead Crane at the Camden Iron Works

overhead crane, of which one end is fixed and the other travels on a circular track having a radius of 100 feet. Electric motors are also used to operate two cranes which were formerly operated by hydraulic power. Other motors furnish power to the various iron working machines in the shops.

In another steel works, some novel applications of the electric motor have been made. For example, a motor is installed on a charging and drawing machine, arranged so as to automatically grip and withdraw the hot bloom from the furnace, and release it when clear of the furnace door. The motorman has simply to start and stop the motor. Another motor in the same works drives a car used for handling ladles containing forty tons of molten steel. It has been in constant use

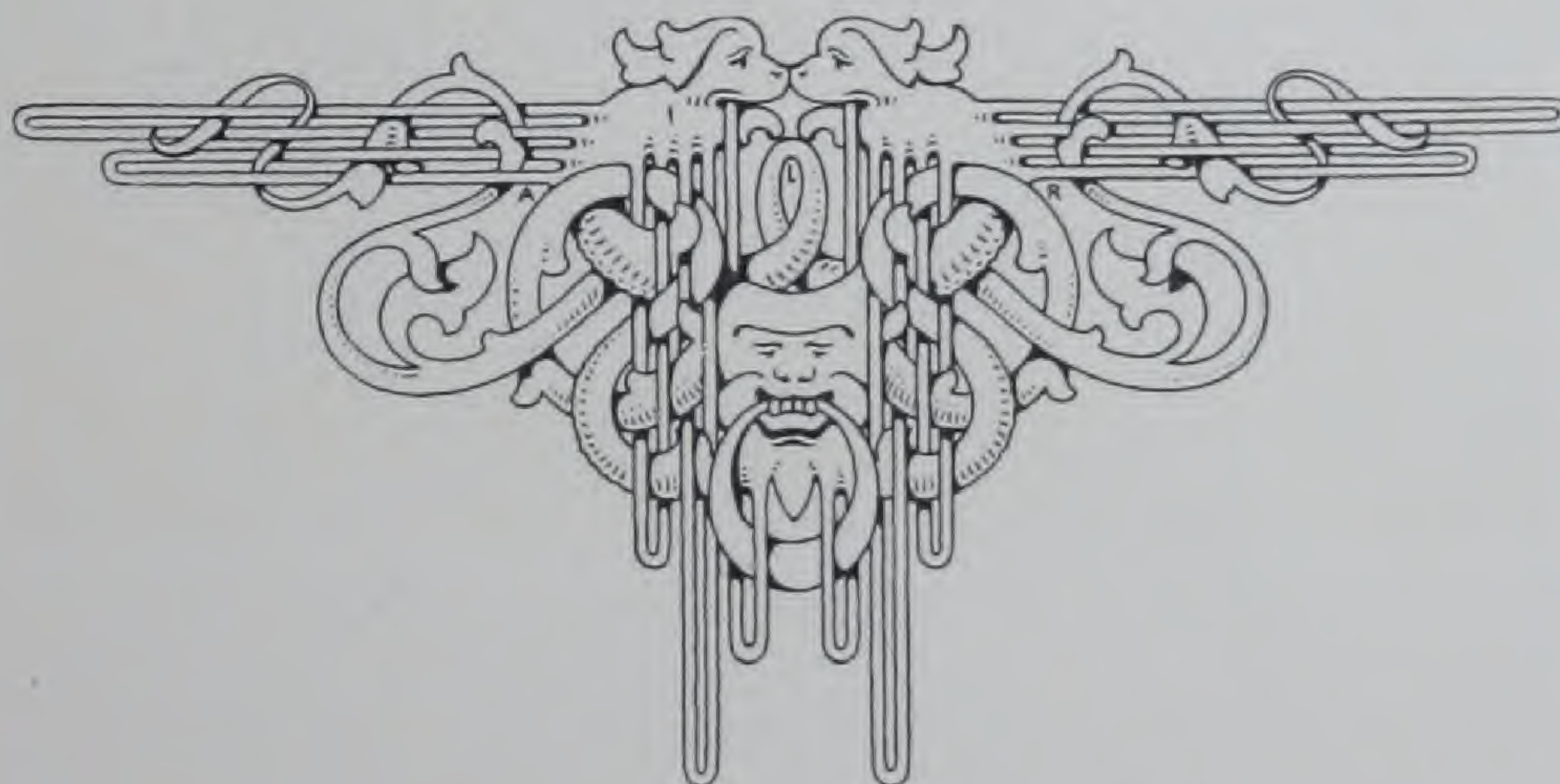
GENERAL ELECTRIC COMPANY

for over four years, and no trouble has yet been experienced from flying sparks or splashes of cinder and steel.

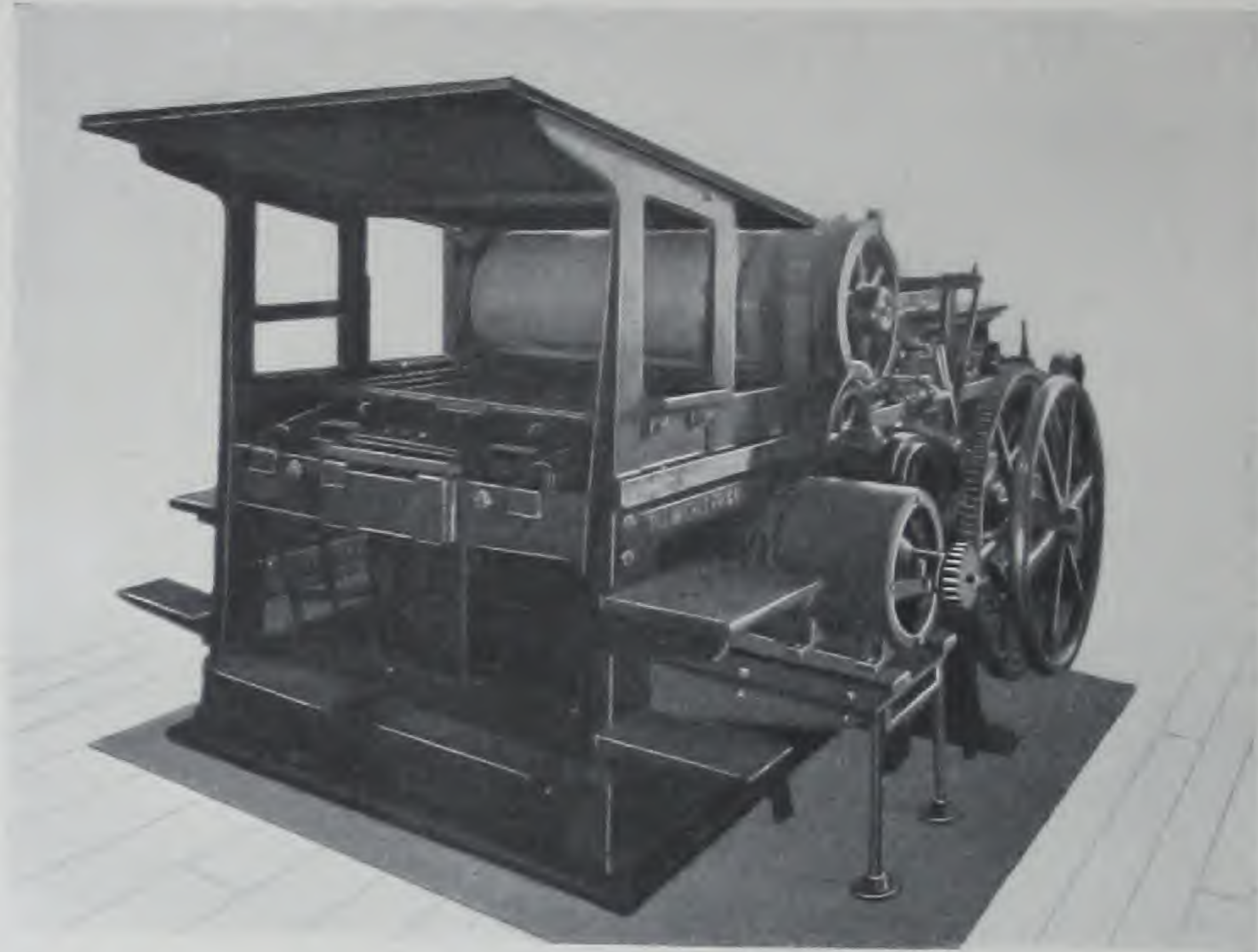
An interesting steel plant is that of Wm. Wharton, Jr. & Co., Philadelphia, Pa., where railway supplies such as crossings, frogs, switches, etc., are manufactured. There are installed about twenty motors, aggregating over 200 horse-power. Most of the motors are directly connected to the tools which they operate, and many are arranged for variable speeds. Among the tools thus equipped are rail cutters, planers, rail benders, rail straighteners, punches, drills, and emery wheels.

The following are a few of the prominent iron and steel works that have installed the General Electric Company's apparatus :

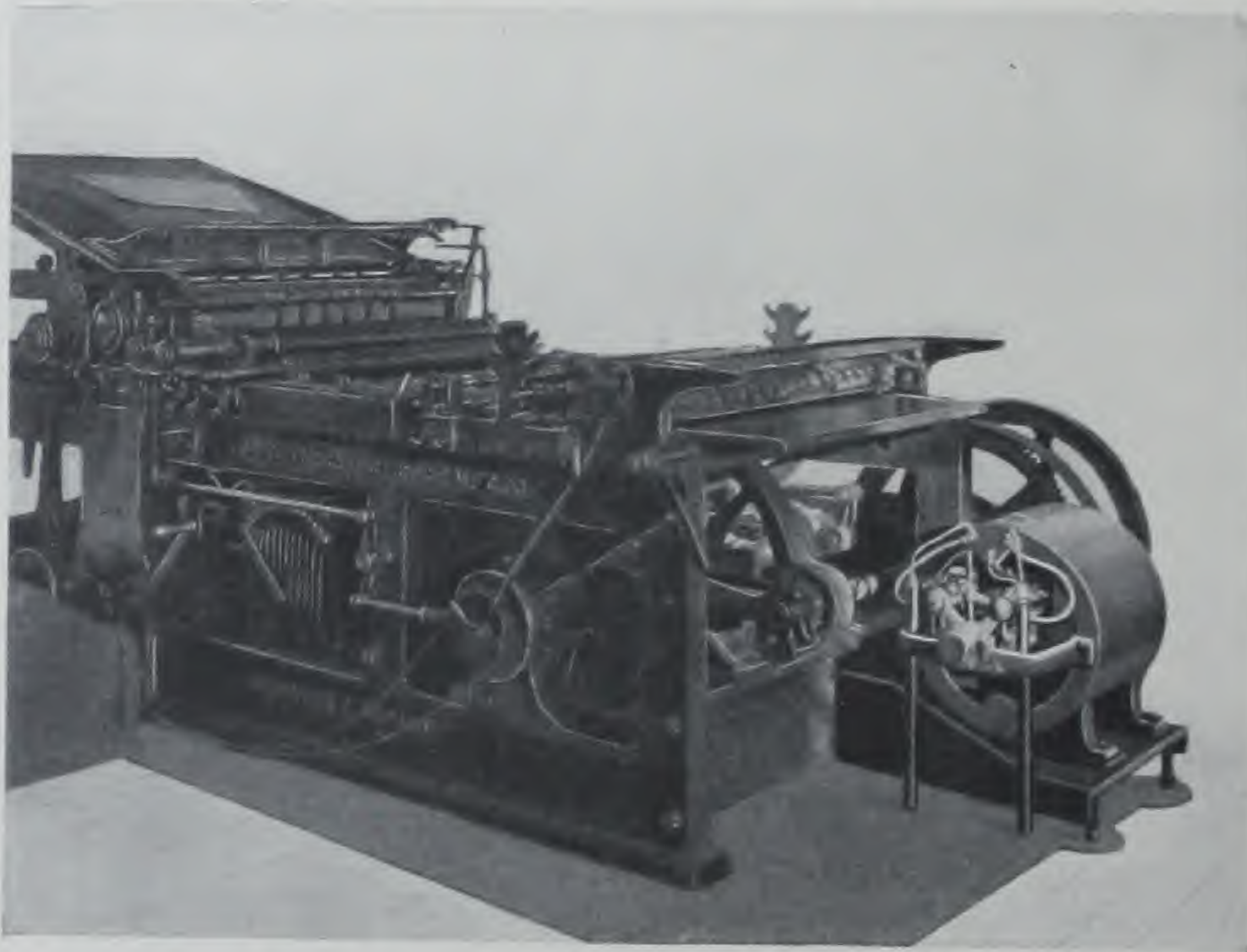
PENNSYLVANIA STEEL COMPANY,	STEELTON, PA.
NEWTON MACHINE TOOL WORKS,	PHILADELPHIA, PA.
BETHLEHEM IRON WORKS,	SO. BETHLEHEM, PA.
CAMBRIA IRON WORKS,	JOHNSTOWN, PA.
PENCOYD IRON WORKS,	PENCOYD, PA.
BATH IRON WORKS,	BATH, ME.
THE JOHNSON COMPANY,	SOUTH LORAIN, O.
OTIS STEEL COMPANY,	CLEVELAND, O.
EDGAR THOMPSON STEEL WORKS,	BESSEMER, PA.
MIDVALE STEEL COMPANY,	PHILADELPHIA, PA.
CARNEGIE STEEL COMPANY,	BESSEMER, PA.
HOMESTEAD STEEL WORKS,	MUNHALL, PA.
AMERICAN STEEL CASTING COMPANY,	THURLOW, PA.
AMERICAN IRON & STEEL COMPANY,	PITTSBURG, PA.
THE BUHL STEEL COMPANY,	SHARON, PA.
CASE MANUFACTURING COMPANY,	COLUMBUS, O.
ILLINOIS STEEL COMPANY,	JOLIET, ILL.
LAKE SHORE FOUNDRY COMPANY,	CLEVELAND, O.
MARYLAND STEEL COMPANY,	SPARROW'S POINT, MD.
NORTON IRON WORKS,	EAST EVERETT, MASS.
OHIO STEEL COMPANY,	YOUNGSTOWN, O.
AMERICAN STEEL FOUNDRY COMPANY,	ST. LOUIS, MO.



GENERAL ELECTRIC COMPANY



Electrically Driven Printing Presses of the Hall Lithographic Co., Topeka, Kan.



PRINTING MACHINERY

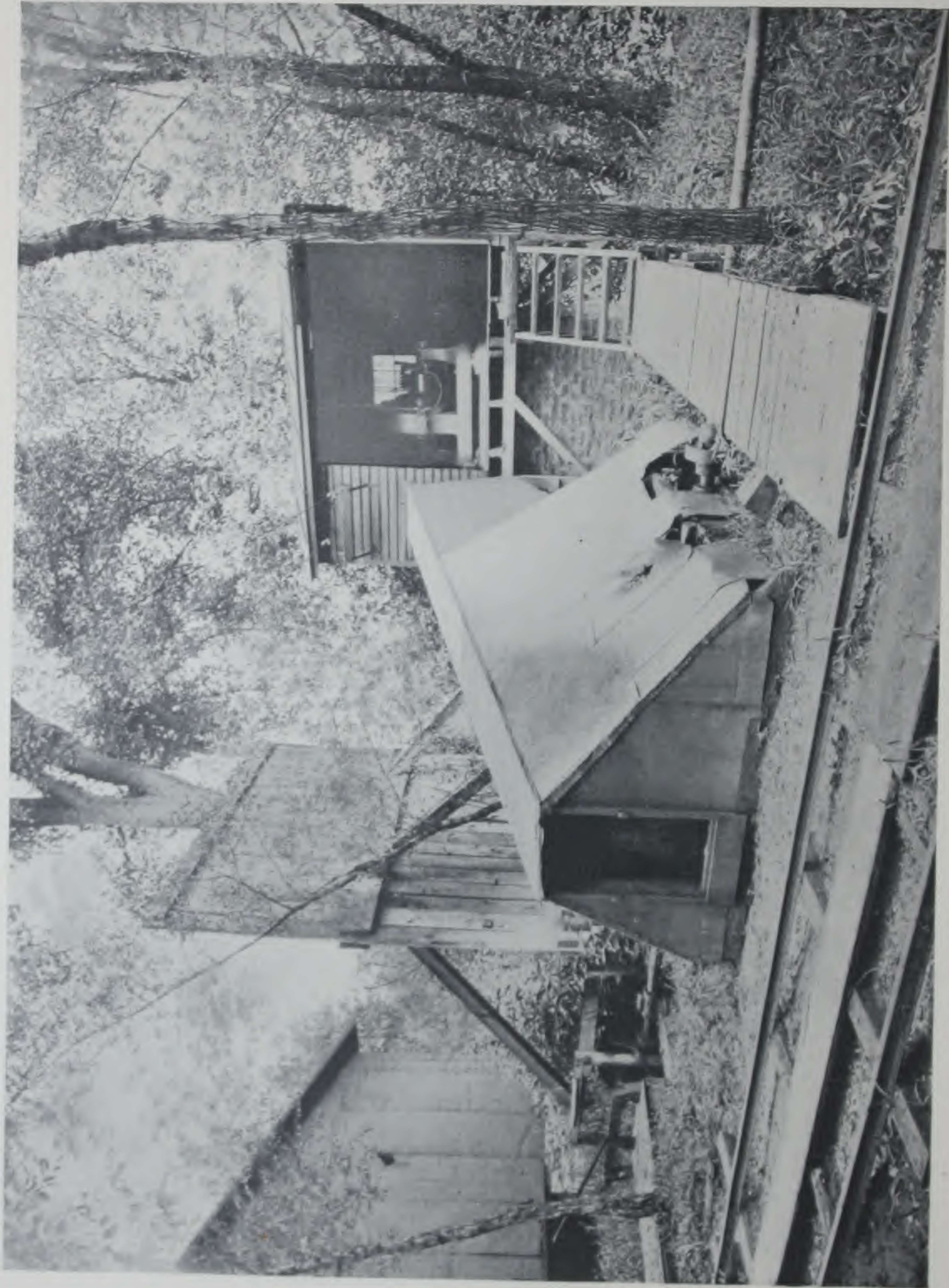
ELECTRIC motors could be adopted with economy by every printing establishment in the country. The work of a printing press is unavoidably intermittent, and the advantages of motors for such use have already been mentioned. The ideal method of installing the motors is to connect them directly to the presses, but in many instances, a line shaft and belts may be used with satisfactory results. However, in such a case the full benefits of variable speed cannot be obtained, and such advantages are by no means unimportant. For the preliminary impressions, the press must be run slowly; later the speed should be increased to the maximum limit, which varies according to the nature of the work. This variable speed cannot be obtained from a mechanical drive without the use of expensive and cumbersome apparatus.

The Hall Lithographic Company of Topeka, Kansas, has equipped its establishment with motors, and the accompanying illustrations show two of its presses with directly connected motors. The controlling rheostat is convenient to the pressman, so that he may have the press under perfect control at all times. The General Electric Company has installed motors in the following printing establishments:



General Electric Company's CA Motor Direct Connected to a Golding Printing Press

BUREAU OF ENGRAVING AND PRINTING,	WASHINGTON, D. C.
BALTIMORE SUN,	BALTIMORE, MD.
BRANDAU PRINTING COMPANY,	ALBANY, N. Y.
THE COLLIERY ENGINEER,	SCRANTON, PA.
COLUMBUS EVENING DISPATCH,	COLUMBUS, O.
ROBERT DAMON,	SALEM, MASS.
GLOBE NEWSPAPER COMPANY,	BOSTON, MASS.
R. HOE & COMPANY,	NEW YORK CITY.
HARPER & BROTHERS,	NEW YORK CITY.
THE HOSTERMAN PUBLISHING COMPANY,	SPRINGFIELD, O.
J. B. LYON,	ALBANY, N. Y.
GEORGE W. MUNROE,	NEW YORK CITY.
NEW HAMPSHIRE REPUBLICAN PRESS ASSOCIATION,	CONCORD, N. H.
PHILADELPHIA TELEGRAPH,	PHILADELPHIA, PA.
PRESS-POST PRINTING COMPANY,	COLUMBUS, O.
RHODE ISLAND LABEL COMPANY,	PROVIDENCE, R. I.
SHEBOYGAN HERALD,	SHEBOYGAN, MICH.
SUN PRINTING & PUBLISHING COMPANY,	NEW YORK CITY.
TIMES-REPUBLICAN,	MARSHALLTOWN, IA.
C. VAN BENTHUYSEN & SONS,	ALBANY, N. Y.
T. E. MUNSEY,	NEW YORK CITY.



ELECTRIC POWER PLANT OF THE KING POWDER COMPANY, KING'S MILLS, OHIO

POWDER MILLS

THE peculiar conditions existing in powder mills offer a field for electric power which cannot in any other way be filled so satisfactorily and economically. Owing to the hazardous nature of the product, and the danger of an explosion in any stage of the manufacture, the various operations are conducted as far apart as the grounds will permit, so that an explosion in one mill may not affect the others. To use a mechanical drive means an enormous expenditure of money in shafting and an equal loss in power transmitted.

Electric power is cheaper to install and it decreases the losses. Another great advantage is that it affords a means of lighting the mills by electric lamps, and thus permits night work without fear of accidents. The illustration shows a General Electric motor driving two powder mills at the works of the King Powder Company, King's Mills, Ohio. The installation includes a central power plant of 550 horse-power output and eighteen motors aggregating 672 horse-power. The following letter from the King Powder Company is one of many which testify to the efficiency of the electric drive:

CINCINNATI, Ohio, Nov. 15, '98.

GENERAL ELECTRIC COMPANY,
SCHENECTADY, N. Y.

GENTLEMEN:—We are not able to state definitely or in exact figures the amount of benefit to us, but we are satisfied it is a great improvement over our old method of running by steam and water. For one thing, it has enabled us to make larger use of our water power than ever before, in that we are enabled to concentrate our wheels at a point where we obtain the greatest fall, and distribute from there over our plant by electric transmission. As we are certain that when obliged to use steam, much less is required to do the same amount of work than formerly, when we had to transmit through long lines of shafting. The fact that all our mills and factories are so united that they instantly help each other and utilize every fraction of horse-power generated at the power-house enables us to run the entire plant on a much less expenditure of power than formerly. We think that it also contributes to the quality of the output in that uniform speed is secured. In every way, so far as discovered, we find that our present system of electric transmission is far superior to the old method in economy of power, in ease and simplicity of running, in amount and quality of output, although the exact figures, as said, we are not able to give.

Yours very truly,

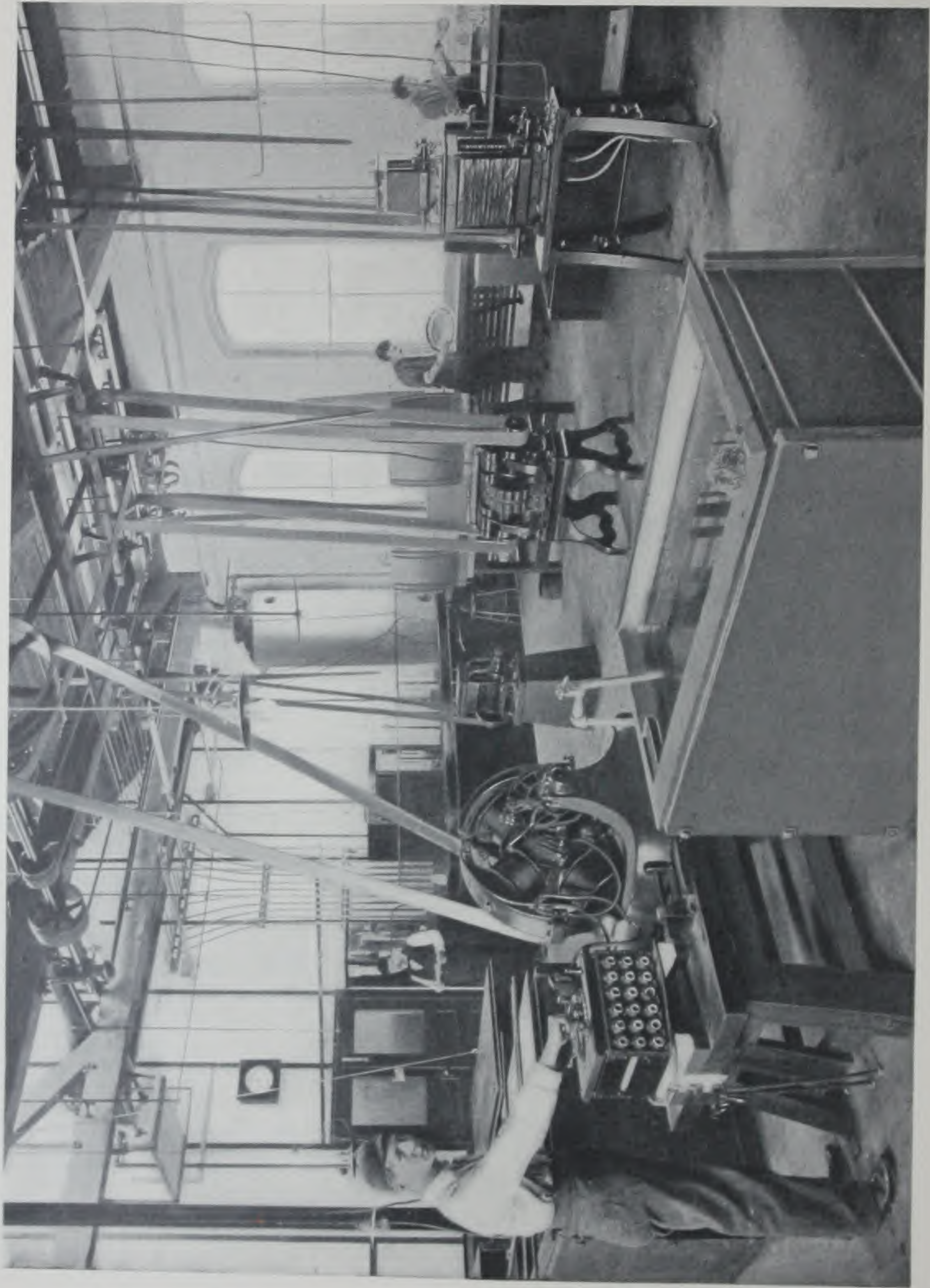
(Signed)

G. W. PETERS, Prest.

Other powder mills using electricity as a motive power and General Electric apparatus, are:

ÆTNA POWDER COMPANY,	ÆTNA, IND.
AMERICAN POWDER MILLS,	CONCORD, MASS.
AMERICAN SMOKELESS POWDER COMPANY,	POMPTON, N. J.
LAFLIN & RAND POWDER COMPANY,	POMPTON LAKES, N. J.
MIAMI POWDER COMPANY,	XENIA, OHIO.
PETERS CARTRIDGE COMPANY,	KING'S MILLS, OHIO.
SCHAGHTICOKE POWDER COMPANY,	SCHAGHTICOKE, N. Y.





GILDING ROOM OF TIFFANY & COMPANY'S JEWELRY FACTORY AT FOREST HILL, N. J.

JEWELRY FACTORIES

THE accompanying illustration shows Tiffany & Company's factory at Forest Hill, N. J. This building was completed in 1896, and electric power was chosen to operate the machinery in view of its manifest advantages. The power plant, which consists entirely of General Electric apparatus, is centrally located, and includes two 100 Kw., 250 volt direct current belt driven generators and 30 motors, aggregating 397 horse-power in capacity. The largest motor has a capacity of 50 horse-power and the smallest 3 horse-power.

The Kent & Stanley Company of Providence, R. I., jewelry manufacturers, and the Elgin National Watch Company of Elgin, Ill., also employ electricity.



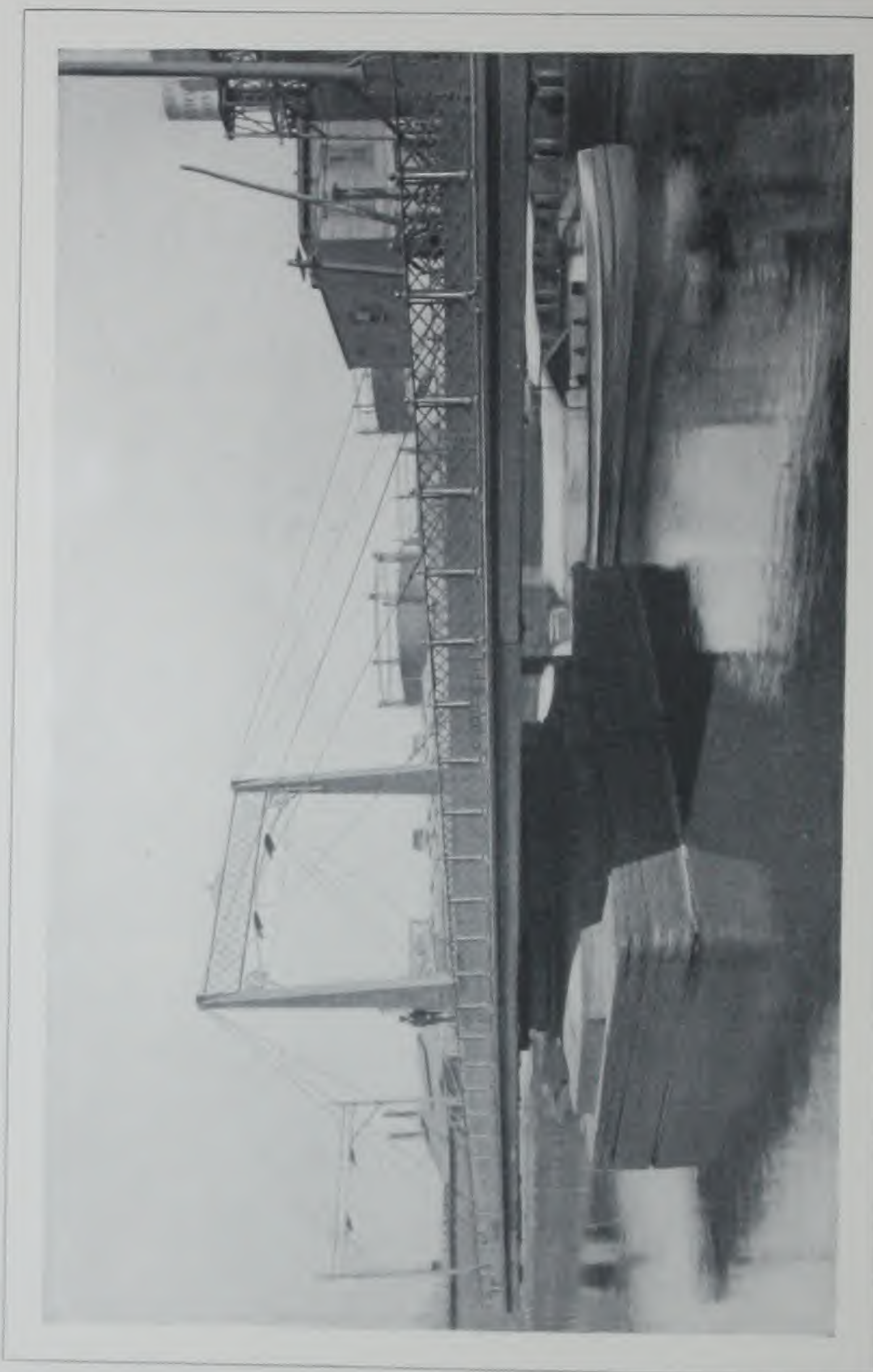
Factory of Tiffany & Company at Forest Hill, N. J.

SUGAR FACTORIES

THE profit in the manufacture of sugar is made up of such a small percentage on the annual sale of enormous quantities that an economical and reliable system of power is absolutely essential. The General Electric Company has supplied electrical machinery to some of the largest sugar refineries in the United States, and the universal testimony is that electricity is the most desirable power for this class of work.

Among electrically operated sugar refineries are the following:

ARBuckle BROTHERS,	BROOKLYN, N. Y.
THE AMERICAN SUGAR REFINING COMPANY,	BROOKLYN, N. Y.
NEW YORK SUGAR REFINING COMPANY,	NEW YORK CITY.
OXNARD CONSTRUCTION COMPANY,	HUENEME, CAL.
SPRECKELS SUGAR COMPANY,	SALINAS, CAL.
WESTERN BEET SUGAR COMPANY,	WATSONVILLE, CAL.



Drawbridge over the Gowanus Canal at Hamilton Ave., Brooklyn, N. Y., Operated by General Electric Company's Motors

DRAWBRIDGES AND LIFTBRIDGES

ELECTRICITY has a specially valuable field in connection with the operation of drawbridges and liftbridges. Speed and control are the requisites of modern methods, and the old plan of operating a drawbridge by a capstan worked by several men is now practically obsolete. A few years ago, the drawbridge at Hamilton Avenue over the Gowanus Canal in Brooklyn, N.Y., was operated by from three to five men working on a capstan. Then it took four or five minutes to complete the operation. The electric motor which has been substituted opens and closes the bridge in fifty seconds, and the services of but one man are needed.

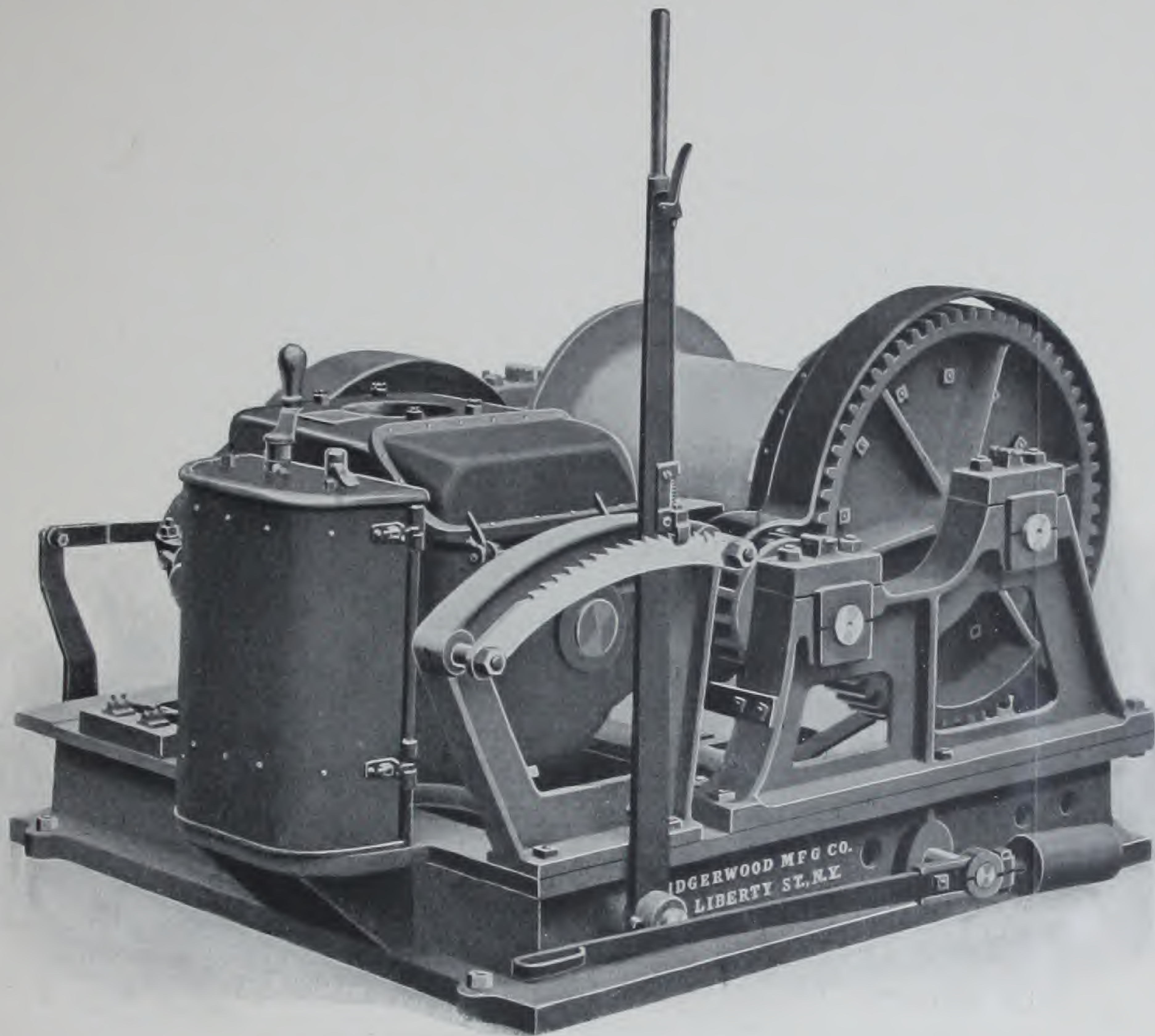
When electric current can be obtained, practically all drawbridges now designed are constructed to operate by electric motors. Among those already installed with General Electric apparatus may be mentioned the following:

DULUTH,	SUPERIOR, MINN.
METROPOLITAN AVENUE,	BROOKLYN, N. Y.
HAMILTON AVENUE,	BROOKLYN, N. Y.
CHELSEA STREET,	BOSTON, MASS.
DOVER STREET,	BOSTON, MASS.
EAST WASHINGTON AVENUE, . . .	BRIDGEPORT, CONN.
NEW BEDFORD AND FAIRHAVEN, .	NEW BEDFORD, MASS.
JACKSON STREET,	CHICAGO, ILL.
WASHINGTON STREET,	CHICAGO, ILL.
LAKE STREET,	CHICAGO, ILL.
STATE STREET,	CHICAGO, ILL.
CLARK STREET,	CHICAGO, ILL.
DEARBORN STREET,	CHICAGO, ILL.
EIGHTEENTH STREET,	CHICAGO, ILL.
RUSH STREET,	CHICAGO, ILL.
RANDOLPH STREET,	CHICAGO, ILL.
WELLS STREET,	CHICAGO, ILL.
ADAMS STREET,	CHICAGO, ILL.
HALSTEAD STREET (Liftbridge), .	CHICAGO, ILL.

GENERAL ELECTRIC COMPANY



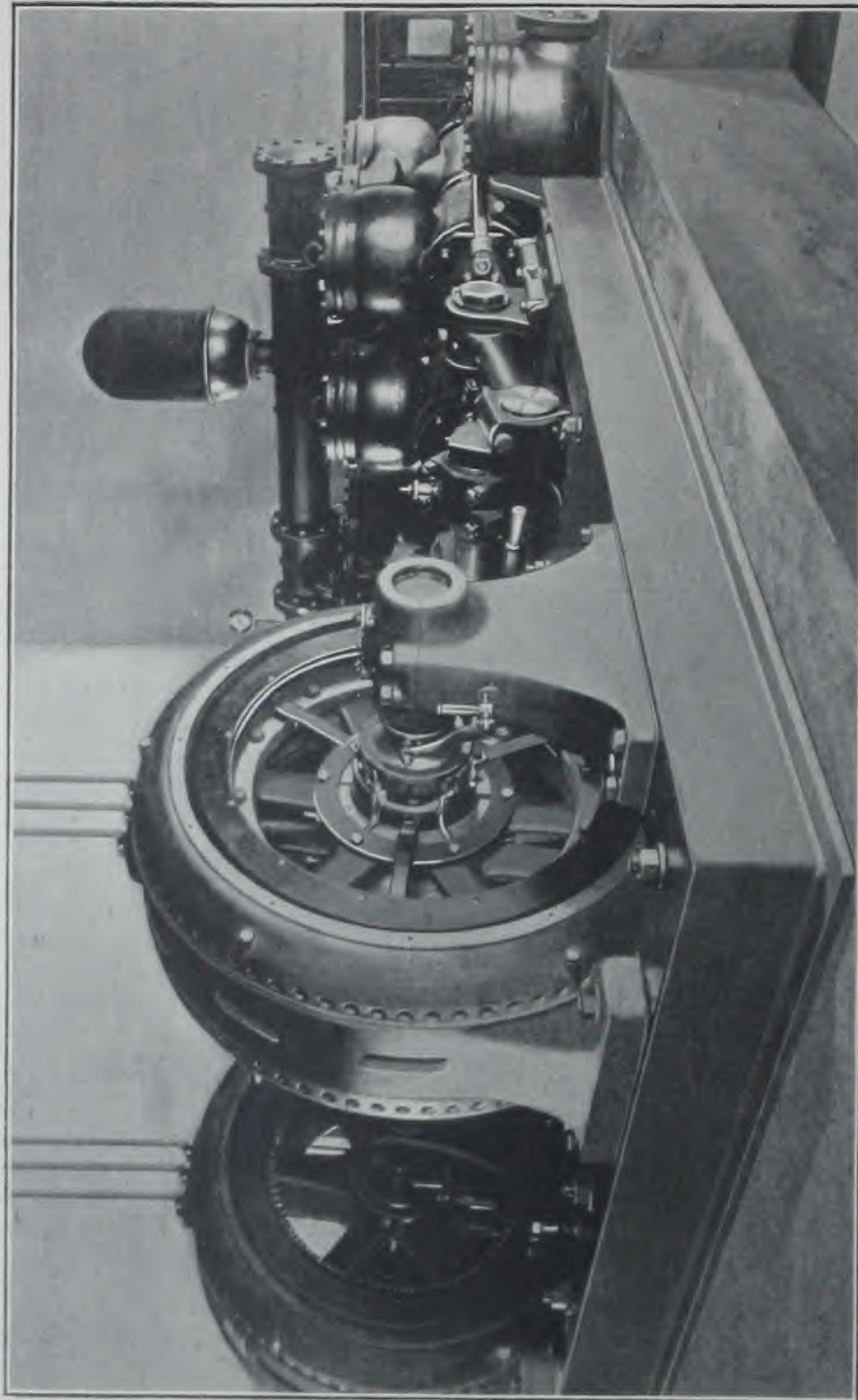
Drawbridge at Duluth, Minnesota, Operated by General Electric Company's Motors



Friction Drum Electric Hoist with Direct Current Motor

PUMPS AND HOISTS

THE application of electric motors to pumps and hoists is so large a subject that it requires special consideration. The General Electric Company manufactures electrically driven pumps and hoists for all varieties and classes of work. The above cut and that on the following page show both hoists and pumps driven by electric motors. Additional information on electrically driven pumps and hoists will be furnished on application.



Horizontal Triplex Pump with Two General Electric Company's Induction Motors

MISCELLANEOUS APPLICATIONS

IN general, it may be said that electricity is applicable to all types of machinery and that by its use we obtain economy, higher efficiency of operation, greater speed, more uniformity as well as increased production.

The following are among the most interesting novel applications of electricity :

CHEESE AND CREAM FACTORY.
CORDAGE MACHINERY.
LOADING AND UNLOADING VESSELS.
OIL CLOTH WORKS.
CONCENTRATING MACHINERY.
COFFEE MILLS.
CASH AND PARCEL CARRIERS IN STORES.
CARBON MANUFACTORY.
CELLULOID MANUFACTORY.
BISCUIT MANUFACTURING.
WHOLESALE DRUG WAREHOUSES.
BRICK MACHINERY.
DIAMOND CUTTING MACHINERY.
DRIVING CAROUSAL.
SHEEP AND HORSE SHEARING MACHINES.
MEAT PACKING ESTABLISHMENTS.
PACKING HOUSES.
CIGAR FACTORY.
CANDY MANUFACTORY.
MANUFACTURE OF BUTTONS.
FRUIT PACKING.
PLATE GLASS MANUFACTORY.
BELTING MACHINERY.
ICE AND REFRIGERATING MACHINERY.
PAPER MILLS.
MANUFACTURING CEMENT.
STARCH MANUFACTORY.
MANUFACTURING JUTE BAGS.
ASSAY MACHINERY.
STAMP CANCELING MACHINES.
CHEMICAL WORKS.
ORGAN BLOWING MACHINERY.
PAINT MILLS.
VARNISH WORKS.
SOAP FACTORY.

FURNISHING MOTIVE POWER TO A CATAMARAN USED FOR
TRANSPORTING BUILDING MATERIALS IN SEWER.

GENERAL ELECTRIC COMPANY

Sales Offices :

BOSTON, MASS., 200 Summer Street.
NEW YORK, N. Y., 44 Broad Street.
Syracuse, N. Y., Sedgwick, Andrews & Kennedy Bldg.
Buffalo, N. Y., Ellicott Square Building.
PHILADELPHIA, PA., 509 Arch Street.
Baltimore, Md., 227 E. German Street.
Pittsburg, Pa., 502 Tradesmens Bank Building.
ATLANTA, GA., Equitable Building.
New Orleans, La., 917 Hennen Building.
CINCINNATI, OHIO, 420 West Fourth Street.
Columbus, Ohio, 14 North High Street.
Nashville, Tenn., Room 73, Cole Building.
CHICAGO, ILL., Monadnock Building.
Detroit, Mich., 704 Chamber of Commerce Bldg.
St. Louis, Mo., Wainwright Building.
Dallas, Texas, Scollard Building.
Helena, Mont., Electric Building.
Minneapolis, Minn., Phoenix Building.
DENVER, COLO., Kittredge Building.
Salt Lake City, Utah, Templeton Building.
SAN FRANCISCO, CAL., Claus Spreckels Building.
Portland, Ore., Worcester Building.
Los Angeles, Cal., Douglas Building.

For all Business outside the United States and
Canada: Foreign Dept., Schenectady, N. Y.,
and 44 Broad Street, New York.

For Canada, address Canadian General Electric
Company, Ltd., Toronto, Ontario.

Principal Offices, Schenectady, N. Y.





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